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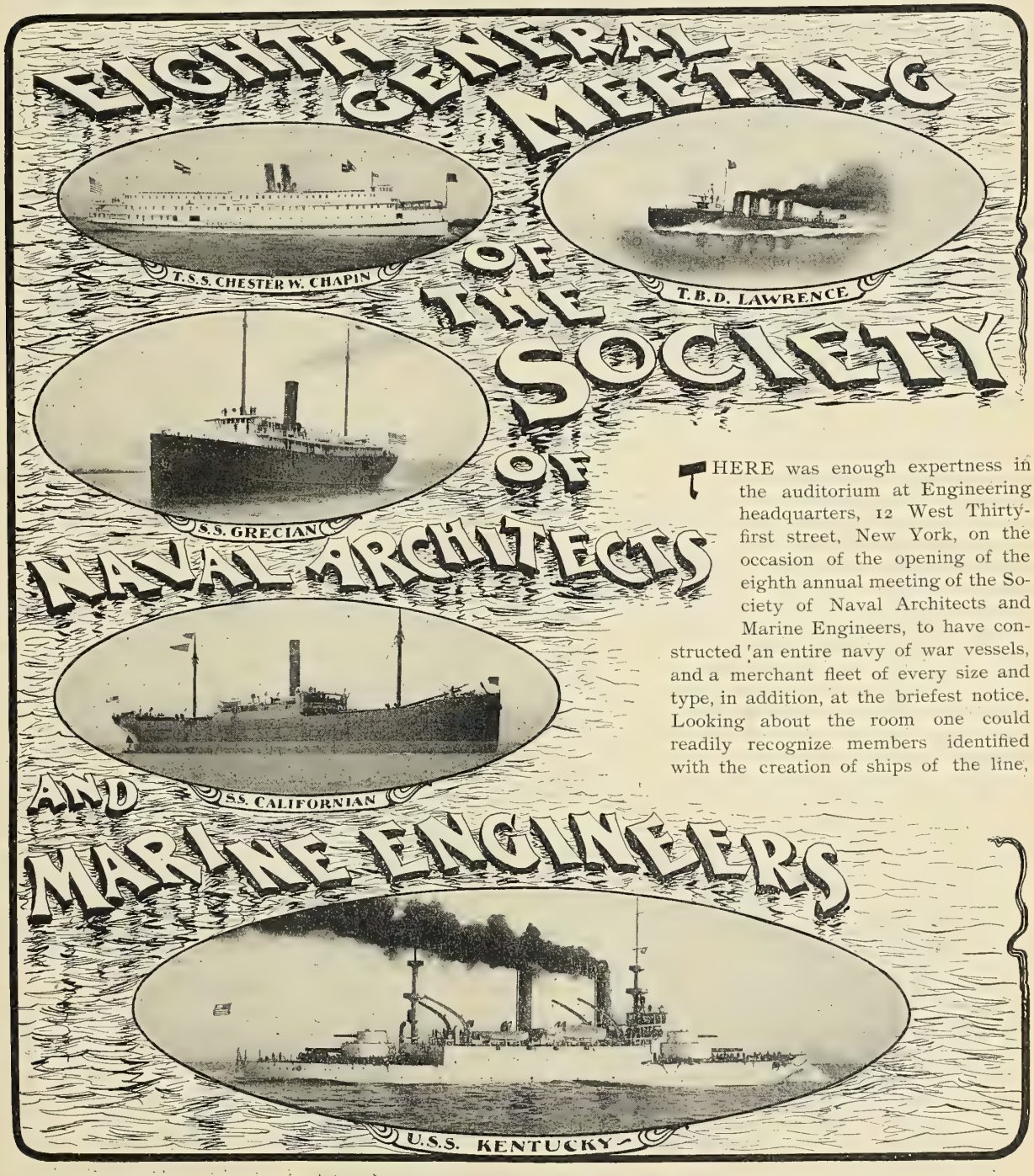

THERE was enough expertness in the auditorium at Engineering headquarters, 12 West Thirty-first street, New York, on the occasion of the opening of the eighth annual meeting of the Society of Naval Architects and Marine Engineers, to have constructed an entire navy of war vessels, and a merchant fleet of every size and type, in addition, at the briefest notice. Looking about the room one could readily recognize members identified with the creation of ships of the line,

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cruisers, torpedo boats, coast liners, deep sea vessels, and pleasure yachts; in fact, boats of every size and style, for there are fashions in boats as in garments, and besides the naval architect, the marine engineer, pure and simple, claimed his share of the floor. There were many all the way up or down, as you will, from the side wheel engine expert to the man who juggles with two hundred-odd pounds and piston speeds beyond the thousand mark. These members had come from the Coasts, the Lakes, and beyond the seas to take part in this the event of the year in marine construction circles. Some, whom the present boom in construction kept at home, were heard in written argument, so that while not in the count of heads their views were heard in debate. There were the ingredients proper to a successful gathering, the weather was propitious, the members enthusiastic, and the presidential address told not only of the profitable present, but forecast an increasing share of the world's tonnage for American skill.

It was singularly unfortunate, therefore, that the peace and dignity of the meeting should have been interrupted at the closing session by the introduction of personalities in purely technical discussion.

An unexpected feature of the meeting was the announcement by Secretary-Treasurer Francis Bowles that a member of the Council had offered a prize of one hundred dollars for the best paper, presented at the next meeting, on a subject to be selected. The choice fell upon the topic of "Theoretical and Practical Methods for Balancing Marine Engines."

Another unexpected feature was the contribution of a paper on the recent trial performances of the Russian Cruiser *Variag*, read at the meeting by Charles Cramp, a member of the firm of builders of this speedy vessel. Mr. Cramp, on behalf of his firm, extended a cordial invitation to the members to visit the ship yard on the Delaware, and on the day after the meeting, November 17, a special train conveyed the guests to the Cramps' Ship Yard, where they inspected the *Variag* and were hospitably entertained at luncheon.

An invitation to attend the Glasgow Engineering Congress, to be held in September, 1901, in connection with the Glasgow Exposition, was announced by the President as having been received. Upon the suggestion of the Secretary members who contemplated making the trip to the Glasgow conference next year were requested to send in their names so that the Executive Committee could appoint a committee to represent the Society at the Congress.

President Clement A. Griscom, who was abroad when the 1899 meeting was held, was in the chair when the eighth general meeting was called to order. First in the order of business was action on the annual financial statement.

ANNUAL REPORT OF SECRETARY-TREASURER.

Secretary-Treasurer Francis T. Bowles reported a total membership of 669, an increase of about 100 over the number in the previous report, and this amount was increased by nearly 100 new applications for membership, to be voted in at the meeting. During the year five members had died:

Members—Stephen A. Gardner, J. G. A. Meyer, Isaac G. Sowter. *Associates*—S. Dana Greene, Fairman Rogers; and there were twelve resignations, including:

Members—Cipriano Andrade, Henry E. Rhoades, Nisbet Sinclair. *Associates*—Luther Allen, Lester A. Beardslee, Emmanuel Cheneau, Marshall H. Clyde, Millard Hunsiker, G. W. Littlehales, C. L. Ottley, Richard Rush. *Junior*—Edwin B. Katte.

Receipts during the year amounted to $6,115.56, which, with the balance on hand of $3,586.75, made a total of $9,702.31. Expenditures, including investments, reached $8,009.57, leaving a cash balance of $1,692.74 to be carried over. Liabilities of the Society were represented by a cipher, and the resources footed up over $15,000. The report was unanimously adopted.

ADMISSIONS TO MEMBERSHIP.

On the list of applications for admission to membership, recommended by the Council, were included several European engineers who are identified with merchant and naval work. To the home applications juniors contributed a considerable share, showing that the younger element have a live interest in the promotion of the best interests of American marine construction. In this section of the Society there are without doubt many that, as experience ripens, will figure in meetings in the future as authors of valuable papers and leaders in debate. The complete list of new members reads:

Members—Bartlett, Charles H., Draughtsman, Navy Yard, 9 Concord Square, Boston, Mass. Bauer Max Henrich, Asst. Teacher, Royal Technical High School, Berlin, Germany. Bigelow, Frank Lewis, Pres. The Bigelow Co., New Haven, Conn. Brewer, Charles B., Draughtsman-in-Charge Naval Constructor's Office, Maryland Steel Co., Sparrow's Point, Md. Buckelew, Charles Henry, Manager New York Office, Ashton Valve Co., 126 West Fifth street, Plainfield, N. J. Cook, Fred M., Leading Hull Draughtsman, Bath Iron Works, Union Street Court, Bath, Me. Cop, Huibert, Prof. Naval Architecture, Polytechnical School at Delph, Cost Singel 61. Delft, Holland. Davis, Charles H., Consulting Engineer, 99 Cedar street, New York, N. Y. Ebsen, H. L., 230 West street, New York. Elwell, H. P., Fore River Engine Co., Weymouth, Mass. Hall, Thomas S., Supt. Engineer New York and Texas S. S. Co., No. 16 Burling slip, New York, N. Y. Herbert, Frederick D., Consulting Engineer and Naval Architect, 220 Broadway, New York, N. Y. Hopkins, Edward, Chief Draughtsman, Detroit Shipbuilding Co., Detroit, Mich. Hunter, George Burton, Chairman and Director C. S. Swan & Hunter Co., Ltd., Wallsend-on-Tyne, England. Lignola, Raimondo, Naval Constructor Royal Italian Navy, R. Cantiere di Castellamare di Stabia, Italy. Norton, Harold P., Lieutenant, U. S. Navy, Navy Department, Washington, D. C. William F. Palmer, Managing Owner and Designer, No. 27 Hartford street, Dorchester, Mass. Pauli, Sven, Asst. Naval Constructor, Carlskrona Navy Yard, Carlskrona, Sweden. Pfatischer, M., Electro Dynamic Co., Philadelphia. Pommer, Eugene R., Ship Draughtsman, Navy Yard, Boston, 102 Hancock street, Malden, Mass. Row, Reuben Robert, Senior Draughtsman Marine Dept., U. S. Light House Service, 227

S. Broadway, Baltimore, Md. Savage, Silas Anthony, Asst. Supt. Engineer, U. S. Light House Board, Washington, D. C. Scott, John Thomas, Supt. Iron Works' Shops, San Francisco, Cal. Smith, W. B., Crescent Ship Yard, Perth Amboy, N. J. Thomas, C. C., University of New York. Thumm, William F., Charge Designing Dept., Wm. Cramp & Sons E. & S. B. Co., Philadelphia, Pa. Wellington, Frank O., Fore River Engine Co., Weymouth, Mass. Wetherbee, Charles Phelps, Asst. Supt. in Charge Torpedo Boats, Bath Iron Works, Bath, Me. Wheeler, Clifton H., Pres. Wheeler Condenser and Engineering Co., 120 Liberty street, New York, N. Y. Winship, James G., Mechanical Engineer and Salesman, Geo. F. Blake Manfg. Co., 468 Greene avenue, Brooklyn, N. Y. Woody, William Henry, Jr., Asst. Supt. Charge of Hulls, Wm. R. Trigg Co., Richmond, Va.

Advanced from Associate to Member—Ferguson, H. L., Assistant Naval Constructor, Washington. Michael, Lucius M., Draughtsman Harlan & Hollingsworth Co., 1514 Van Buren street, Wilmington, Del. Miller, Spencer, Lidgerwood Mnfg. Co., New York. Wallace, W. M., Computer Bureau Construction and Repair, Navy Department, 616 Eighteenth street, N. W., Washington, D. C. Wilson, G. H., Harlan & Hollingsworth Co., Wilmington, Del. Zahm, Frank Baker, Naval Constructor, U. S. N., Navy Department, Washington, D. C.

Associates—Bent, F., Solid Steel Casting Co., Chester, Pa. Bent, Stedman, Maryland Steel Co., Sparrow's Point, Md. Boas, Emil L., 37 Broadway, New York. Buckelew, Charles William, Ship Designer, 126 W. Fifth street, Plainfield, N. J. Capdevielle, Henry, Ship Draughtsman, Newport News S. B. & D. D. Co., 113 Thirty-third street, Newport News, Va. Clifford, James A., B. F. Sturtevant Co., Boston. Coolidge, Frederic Austin, Copyist Draughtsman U. S. N., Harlan & Hollingsworth Co., Wilmington, Del. Cooper, Percy Gordon, Ship Draughtsman, Newport News S. B. & D. D. Co., 124 Thirty-fifth street, Newport News, Va. Etter, Harry B., Designing Draughtsman, Wm. Cramp & Sons, E. & S. B. Co., 2339 N. Twentieth street, Philadelphia, Pa. Farrington, W. C., Northern Steamship Co., Buffalo. Fergen, Captain William Baron, Naval Attache, Imperial Russian Embassy, 2010 R street, N. W., Washington, D. C. Gibson, Albert N., Draughtsman, U. S. N., Navy Yard, Boston, Mass. Greene, Winthrop Darius, Draughtsman, Bath Iron Works, P. O. Box 855, Bath, Me. Green, C. Cuyler, Draughtsman, Hyde Windlass Co., P. O. Box 1015, Bath, Me. Hill, Geo. H., Sprague Electric Co., New York. Hoffman, John White, Pres. Hoffman Eng. and Contracting Co., Harrison building, Philadelphia, Pa. Hooper, Louis Mosher, Engineer and Mechanical Expert, J. L. Mott Iron Works, Rutherford, N. J. Hughes, Alex., 623 Jefferson street, Portsmouth, Va. Lawley, Arthur C., Draughtsman, Geo. Lawley & Son Corp., 60 N. street, South Boston, Mass. Lynn, James J., Marine Salesman, General Electric Co. and Shelby Tube Co., 4 Butler street, Port Huron, Mich. McBride, James D., New York Ship Building Co., Camden, N. J. Main, Archibald MacNicol, Eastern Ship Building Co., New London, Conn. New, Harry Stuart, Draughtsman, Navy Yard, 221 Newbury street, Boston, Mass. Newberry, Truman H., Detroit. Nolan, John J., Master Mechanic C. and R. Dept., Navy Yard, New York, 271 Adelphi street, Brooklyn, N. Y. Norman, John Hugo, Draughtsman, Wm. Cramp & Sons, E. & S. B. Co., Philadelphia, Pa. Paine, Cecil E., Engineer Hyde Windlass Co., Bath, Me. Patteson, Hugh, Sprague Electric Co., New York. Pierce, Walter Louis, Secretary and General Manager Lidgerwood Mnfg. Co., 96 Liberty street, New York City. Pollock, W. B., Marine Dept., N. Y. C. & H. R. R., New York. Powers, Wilbur Francis, Draughtsman, Harlan & Hollingsworth Co., 1219 Washington street, Wilmington, Del. Raven, Anton A., Pres. American Bureau Shipping, 37 William street, New York, N. Y. Roach, S. W., Morgan Iron Works, New York. Robinson, Richard H. M., Asst. Naval Constructor, U. S. N., Cramps Shipyard, Philadelphia, Pa. Roes, W. Harry, Hull Draughtsman, Wm. Cramp & Sons. E. & S. B. Co., 5420 Jefferson street, Philadelphia, Pa. Ross, Charles E., Morgan Iron Works, New York. Sabin, Alvah Horton, Chemist and Director, Edward Smith & Co., 45 Broadway, New York, N. Y. Schooler, C. V., 511 County street, Portsmouth, Va. Shackford, William Gardner, Retired Shipmaster, South Orange, N. J. Stanton, L. W., *Nautical Gazette*, New York. Thayer, Charles Hinckley, Ship Draughtsman, Newport News S. B. & D. D. Co., 136 Thirty-eighth street, Newport News, Va. Thresher, A. A., Thresher Electric Co., Dayton, O. Tromp, Theodoor Henri Adrian, 1302 Washington street, Hoboken, N. J. Wakeman, S. W., Newport News Shipyard, Newport News, Va. Waters, Geo. H., Asst. Master Mechanic Pennsylvania Co., Jersey City, N. J. West, G. B., Eastern Shipbuilding Co., New London, Conn.

Advanced from Junior to Associate—Swanton, H. A., Harlan & Hollingsworth Co., Wilmington, Del. Tuthitt, Benjamin Cartwright, Asst. Draughtsman, U. S. N., Bath Iron Works, 146 Oak street, Bath Me.

Advanced from Junior to Member—Delong, H. W., Marine Dept., Maryland Steel Co., Sparrow's Point, Md. Sperry, Austin, Fulton Engineering and Shipbuilding Co., San Francisco.

Juniors—Baum, A. E., 32 Western avenue, Bath, Me. Bimson, James A., Draughtsman, Engineering Dept., Bath Iron Works, Bath, Me. Crain, John Jay, Draughtsman, N. S. N., Newport News S. B. & D. D. Co., 329 Forty-ninth street, Newport News, Va. Cutler, Edward Osgood, Draughtsman, U. S. N., Bath Iron Works, 97 Oak street, Bath, Me. Damon, Edward O., Jr., 83 Pomroy terrace, Northampton, Mass. Dawson, Noble Edmunds, Jr., Hull Draughtsman, Newport News S. B. &. D. D. Co., 3406 West avenue, Newport News, Va. Ellis, Walter L., Draughtsman, Bath Iron Works, Bath, Me. Evans, John Lancaster, Ship Draughtsman, Bath Iron Works, P. O. Box 838, Bath, Me. Frieble, John F., Draughtsman Hull Dept., Newport News S. B. & D. D. Co., P. O. Box 92, Newport News, Va. Grieshaber, Hugo Eugene, Merchant Draughtsman, Newport News S. B. & D. D. Co., P. O. Box 92, Newport News, Va. Hibbard, Harry Lyman, Asst. Ship Draughtsman, Naval Construction Office, Newport News, Va., Chas. Haynes Hughes, Ship Draughtsman, Bath Iron Works 658 Washington street, Bath, Me. Hunt, Herman Reynolds, Ship Draughtsman, U. S. N., 719 St. Nicho-

las avenue, New York, N. Y. Jenkins, Sanford Cuyler, Draughtsman, Wm. R. Trigg Co., Box 861, Richmond, Va. Leitch, A. C., Navy Yard, New York. Loomis, Allen, Draughtsman, Hanley Construction Co., Quincy, Mass. Lord, Robt. William, Hull Draughtsman, Bath Iron Works, 25 Linden street, Bath, Me. Mitchell, Leland R., Marine Engine Draughtsman, Bath Iron Works, 476 Middle street, Bath, Me. Newton, William Buxton, Engine Draughtsman, Bath Iron Works, 850 Washington street, Bath Me. Schoonmaker, Frederick, Draughtsman, Hull Dept., Bath Iron Works, 146 Oak street, Bath, Me. Page, Charles Barnard, Engine Draughtsman, Maryland Steel Co., Sparrow's Point, Md. Wright, Henry C., Jr., Hull Draughtsman, Wm. R. Trigg Co., Richmond, Va. Yeomans, Clifton, Draughtsman Hull Dept., Newport News S. B. & D. D. Co., P. O. Box 60, Newport News, Va. Young, William J. J., Asst. Draughtsman, U. S. N., Geo. Lawley & Son, 15 Cottage Side, Dorchester, Mass.

ELECTION OF OFFICERS.

The only change in the existing list of officers is the addition to members of the Council of Walter A. Post. For the ensuing year, therefore, the officers of the Society will include: President, Clement A. Griscom; Vice-Presidents, W. Irving Babcock, Francis T. Bowles, Washington L. Capps, French E. Chadwick, James E. Denton, George W. Dickey, William F. Durand, Edward Farmer, H. T. Gause, Nathaniel G. Herreshoff, William H. Jaques, John C. Kafer, Frank B. King, Frank E. Kirby, Walter M. McFarland, Jacob W. Miller, Lewis Nixon, Cecil H. Peabody, Walter A. Post, Harrington Putnam, Horace See, E. Platt Stratton, Stevenson Taylor, George E. Weed; Executive Committee, Francis T. Bowles, Chairman; H. T. Gause, Harrington Putnam, Lewis Nixon, Edwin A. Stevens, Clement A. Griscom, ex-officio; Secretary and Treasurer, Francis T. Bowles.

Routine business matters having now been disposed of, President Clement A. Griscom read his annual address.

PRESIDENT GRISCOM'S ADDRESS.

"*Gentlemen:* I am grateful for the continued evidence of your confidence, which I highly appreciate.

"The long list of new members we shall add to our rolls at this meeting is but one of the abundant signs to be read in the industrial, financial and political life o fthese November days, of a national determination to promote shipbuilding, commercial and naval. In pursuit of its special object this Society, I confidently predict, has an immediate future of great usefulness to our country.

"The most prosperous year shipbuilding in the United States has known since the outbreak of the Civil War nears its end.

"The new year and the century about to begin bid fair to witness a development of the industry responsive to our high hopes at the time the Society of Naval Architects and Marine Engineers was founded.

"During the fiscal year of the Government which ended in June, eighty steel steam vessels of 167,948 gross tons were built in the United States. These figures are modest compared with Great Britain's output of 567 steel steam vessels of 1,341,425 gross tons during the year; but they are full of encouragement when put beside the fact that during the previous nine years the United States built only 574,802 gross tons of these types. Nearly all our ship yards have been busy, every large plant has increased its capacity, and several new ship yards have been established and equipped for the construction of the largest merchant and war vessels. The new ship and engine building yard of noble proportions on the Delaware is prepared for work, and its novel applications of mechanical science to shipbuilding have already aroused the interest of the students of marine architecture here and abroad. A new and extensive plant on the Pacific Coast will soon begin operations and on the Thames, in Connecticut, the keels of two of the largest steamships ever built will soon be laid. Plants in the South are increasing their facilities, and, under favorable conditions, steel shipbuilding promises to become one of our distinctively national industries.

"The next twenty-four months will show an increase over the past twenty-four months as great as the records of the latter exceel those of previous periods. Since the end of June there have been launched, begun or contracted for, seventy-eight steel steamships of 350,000 gross tons, including ten ocean steamships, each of 10,000 gross tons or over. Part of this work will extend over a period of two years, but in the twelvemonth from last June, 250,000 tons of steel steamships will have been launched in the United States.

"Unless I mistake its scope, this society has two functions. First, by the interchange of professional ideas to extend to our own knowledge and familiarize ourselves with advances in the technical aspects of the art; and, second, to promote shipbuilding by teaching the value to the nation of the work in which we are all directly or indirectly engaged, and by developing a correct popular understanding of the broad facts of the industries with which we are identified.

"You will not expect a technical paper from me. Such papers have been prepared for the meeting by gentlemen whose abilities in their respective lines of work command the highest professional esteem. But, as your president, I deem it well at this time to point some of the causes which, in my judgment, have brought the recent remarkable growth in American shipbuilding to which the figures just stated testify.

"Most familiar among those causes has been the liberal and continuous expenditure of the Government on the navy. Since 1884-5, seventy-one vessels of over 360,000 tons displacement, not including many torpedo boats and torpedo boat destroyers, have been built or ordered for the navy. The vessels under construction aggregate 113,326 tons displacement, namely: Six battleships. four monitors, six protected cruisers, sixteen torpedo boat destroyers and fifteen torpedo boats, making a total of forty-seven.

"The total value now under construction for the United States navy for hulls and machinery alone involves an expenditure of $33,700,000.

"Vessels have been authorized but not yet begun, namely: Five battleships, six armored cruisers and three protected cruisers, making a total of fourteen, and aggregating 179,800 tons displacement, of which

the hulls and machinery alone will cost approximately $50,400,000, a greater amount than is involved in the entire construction of the merchant steamships of twenty-four months to which I have referred.

"The annexation of Hawaii and causes arising from our war with Spain have stimulated shipbuilding beyond the expectations of the sanguine a few years ago. Among such causes are the extension of the coasting law to Porto Rico, the development of closer relations with Cuba, the absorption of a large tonnage by the Government for transport purposes and especially the certainty that the United States is now impelled by the force of events to assume first rank as a maritime commercial power on the Pacific.

"Under natural and legislative conditions which insure them against external competition and have obtained for them deep channels, our shipbuilders on the Great Lakes have brought the art to a wonderful perfection. Of the increase of 750,000 tons in American shipping during the decade, 500,000 tons—450,000 of which are steel steam vessels—stand to the credit of the shipbuilders and shipowners of the Great Lakes.

"Without transgressing any unwritten rule of the Society in its discussions, I feel justified in stating that among the causes which are now stimulating our shipping interests may be included the growing popular national sentiment that the United States should no longer remain at the tail of the procession of commercial nations on the seas. Within four years our country has won a series of remarkable industrial triumphs, yet Japan, the youngest of nations, surpasses us in the tonnage of ocean steamships engaged in the world's commerce. I shall not presume to discuss here the public measures that may be desirable to meet the situation. Papers will be laid before you on certain phases of the problem, to which your thoughtful attention is invited. I have shown that conditions exist which promise success for a well-considered project, sustained by enlightened public sentiment.

"I congratulate the members upon a programme of unusual interest."

First Technical Session.

The proceedings were opened by the announcement by President Clement A. Griscom of the reading of the first paper on the programme.

CAPACITY TEST OF A UNIQUE FORM OF AIR PUMP.

BY T. W. WHEELER.

The Author, who is a manufacturer of pumps, describes in detail a type of air pump which has been put on the market recently by his firm. It is of the independent variety, and in the steam end is similar to the simplex double acting steam pump arranged on the cross compound plan, built by the Author, and described by him in a paper read before the Society at the 1899 meeting. The air cylinders of this pump are described as of the "suction valveless" principle, each air cylinder being double acting. The discharge valves for the end of the pump are arranged at the top of the air cylinder immediately over the pump barrel, and the discharge valves for the other end are located at one side of the cylinder casting as low as they can be placed. The air piston is a hollow casting of gun metal bronze filled with material of great lightness and water excluding qualities. This piston is sufficiently elongated, and alternately covers and uncovers the suction port at each stroke, this suction or inlet port being located at the center of the cylinder. There are no suction valves and the air piston has no packing rings. Accompanying the paper there are diagrams of the pump, indicator cards and a numerical table of test performances.

DISCUSSION.

MR. KAFER: "I would ask if the indicator diagram of the air pump was from the upper or the lower part of the cylinder, because it would make an essential difference whether the diagram was taken from the upper or lower end. A pump similar to this was designed by Mr. Bailey some years ago. He thought he had a new invention, but he found a similar pump had been designed many years before and a description published in an English engineering paper. There is no question that this style of pump is superior as an air pump, from the fact that the air pump, from the fact that there is no foot-valve or receiving-valve to raise, and, consequently, no pressure of air in the condenser necessary to raise that valve, and it is possible to produce a better vacuum with a valveless pump on the receiving side than it is with one having a valve on it."

W. I. BABCOCK said that one of the most important parts of a marine engine is that portion which is concerned with the production of a vacuum, in which the air pump is the main factor. If this can be associated with simplicity of design, with constancy of operation and with a large saving of weight, it amounts to a very great advantage in engine practice. He asked for specific information as to the construction of the discharge valves referred to in the paper.

MR. WHEELER, in reply to Mr. Kafer's inquiry, said that when the design for a suction valveless pump had been prepared by Mr. Bailey, some years ago, the designer had then thought that he was the originator of the principle; but, as a matter of fact, the Knowles Steam Pump Works made a pump of the suction valveless type for vacuum pans in 1874. It was an efficient pump, but in the course of a year or so it lost its vacuum forming qualities because it was a horizontal pump and, having no vacuum rings, the piston would wear on the lower side and then the pump would leak from the top side. Pumps of this type had also been designed in England. In fact, the Edwards Air Pump, now extensively sold abroad, is on this principle. In reply to the query about the indicator diagram, the speaker forgot whether it was from the lower or upper side. But out of forty or fifty diagrams there was a great difference between the top and the bottom. Air pumps were very eccentric in their action, the speaker said, and there are practically no two diagrams alike. This was especially so when a vessel was in motion, rolling—sometimes there would be a gorge of water and then a scarcity of it—and the diagrams were consequently very irregular. In this pump it was expected that more work

would be done on the lower side than on the upper side of the piston, but the diagrams did not always show this; although the average showed a little more work on the lower side. Naturally, it would be said that the vapors and air would rise and pass off on top, and that the water would gravitate to the bottom, and that, consequently, the lower stroke would be a water stroke and the upper stroke would be a vapor stroke. The vapors, however, mixed more or less with the water in practice, and it was not surprising that a uniformity of diagram was obtained.

JOHN C. KAFER said that not only would the water go to the bottom, but also there would be less vacuum in the lower portion of the pump, due to the clearance space. All this space in the lower portion of the pump would be filled with air or vapor, while in the upper portion all the air and vapor would be discharged.

MR. WHEELER replied that in practice the water filled the lower space so that it was almost solid. With respect to the valve, this was of the type known as the three-disc Kinghorn valve, and was made of manganese or phosphor bronze, carefully fitted, and as tight as a rubber valve. With these valves trouble was sometimes caused, when first starting a pump, by the moulder's sand and dirt in the connecting pipes. To guard against this, the pipes were usually cleaned out before commencing operations. This would, of course, have occasioned less trouble with a rubber valve.

W. D. FORBES inquired whether, when the piston was passing the feed inlet, there was any shock noticeable. Was it a perfectly horizontal slot, or was it partly spiral?

MR. WHEELER responded that it was perfectly horizontal. It went around about three-fourths of the barrel and the piston passed it without any perceptible noise or jar.

W. D. FORBES: "Then the pump was practically noiseless."

MR. WHEELER responded that it was noiseless if proper care was exercised, but that like all air pumps it would pound under certain conditions. He believed that Mr. Bailey had reached similar results in his experiments.

INTERCHANGEABILITY OF UNITS FOR MARINE WORK.

BY W. D. FORBES.

In this brief paper the Author aims to call attention to the desirability in machine construction not only of interchangeability of parts but of units, so that discussion of the subject may be provoked. In opening he states that the great advantage of interchangeable machine parts is nowhere more fully recognized than in the United States, this feature of our construction being one of the strongest recommendations of American machinery to the foreign buyer. The cost of repairs or replacement of apparatus on board ship as compared with costs for like work in the shop is noted by the Author. This is caused in part by the necessity for men going to and fro to the work, and carrying out the work usually in cramped and crowded quarters. He suggests that the Navy is in a position to start a system of interchangeability of units in its auxiliary machinery without in any way making it necessary to use a certain make or style of machine, or without inflicting on the manufacturing public any real burden. It is proposed, for instance, that all generating sets, of whatever make, of the same K. W. output, shall have the base plate holding down bolts in exactly the same position, and the steam inlets and outlets in the same relative positions in vertical and horizontal planes. It does not seem practcal to carry out this idea entirely, the Author believes, but it could be approximated to so that less work would be needed in substituting one size of apparatus for another, even of different makes. Changes in piping are readily made on shipboard, he points out, and if the holding down bolts do not call for changes, the process of replacing apparatus becomes simple. In the commercial world, now, designs are fairly well fixed, but as new designs are being constantly brought out, these could be made to conform to the interchangeable system. The main difficulty is that at present no standard exists, but, the Author believes, were a system adopted, manufacturers would speedily fall into line. A commencement could more readily be made in the Navy, as most of the govermental work is specially gotton up. A standard flange for steam and water connections of pipe is now in use in the Navy. Taking two Admiralty pattern pumps of different sizes as examples, the Author shows by figures that comparatively slight changes would be needed to make the pipe openings and holding down bolt holes in each type coincide. Electric units lend themselves especially to the interchangeable system, as in their case only the position of the steam and exhaust pipes and the holding down bolts would have to be considered. In many existing types few changes would have to be made to secure interchangeability. The same method could be readily adopted for circulating pumps, blower, engines, etc. In some parts of the world, the Author says, small marine engines are made interchangeable, so that instead of making repairs, in place, the engine is lifted bodily out of the hull and another engine dropped in and immediately coupled up. In conclusion, the Author recalls the scepticism with which in days past the proposition to make band pulleys for stock was received. "Engineers insisted that a hole could not be made in Philadelphia, to fit a shaft made in New York." A similar prediction was made when it was proposed to manufacture stock gears. Accompanying the paper are outline dimensional sketches of the Admiralty pumps referred to in the text.

DISCUSSION.

NAVAL CONSTRUCTOR FRANCIS T. BOWLES said: "I believe that this matter which has been brought up by Mr. Forbes is the most important one that this Society can consider in the interest of shipbuilders and shipowners, and I believe that the idea can be carried out in a much larger way possibly than Mr. Forbes has considered. Interchangeability of units is applicable, not only to the fittings of the engine room and auxiliaries of the ship, where it has a noticeably large field, but it can be extended with great economy to the fittings of all vessels, and I would like to say that for the last three years I have

been engaged in preparing standard plans, some of which I have restandardized several times, for customary fittings on board ships, such simple things as eye-bolts, blocks, pulleys, ventilator rings and ventilator cowls, cleats, bits and things of that sort. Now, if the shipbuilders of the United States would get together and agree upon standardizing even such small details as that, it would be an enormous saving. Those things could be produced in large quantities for less than one-third of what they are produced for now, in irregular sizes. The shipowner would never be at a loss to obtain whatever he required immediately, and I consider that this line of improvement is one of the greatest fields in this country to put us ahead of others in the shipbuilding business."

JOHN C. KAFER: "'I fully agree with what Mr. Bowles has said with reference to interchangeability of parts of ships and machinery. Wherever you can interchange parts you can save money, save money for the shipowner more especially. He is the man for whom we want to save money in the end, and the shipbuilder can get his supplies much more readily, but it goes to the manufacturer of these parts to make them uniform. One builder of pumps will not make the pumps exactly the same as another man. He will endeavor to make a change, so as to compel people to come to him for pumps. I mention that without any disparity to the pump makers, merely because the subject of pumps was brought up. But if the manufacturers would endeavor to make them uniform, there would be very little difficulty on the part of the shipbuilders or the shipowners to aid them in the matter. Probably this Society would be the proper place to make a start in that direction. If a committee of shipbuilders and manufacturers would get together and standardize some of the parts, begin with some few things, not attack the whole; but make a small beginning, I think it would lead on to a successful result in the matter."

NAVAL CONSTRUCTOR WILLIAM J. BAXTER said: "One very valuable feature in this paper, which has not been mentioned by Mr. Bowles or Mr. Kafer, is the elastic limit of this method. It allows of variation for the different pump makers, as Mr. Kafer has mentioned, for the different cleats, for the different fittings that will satisfy any particular shipbuilder, or any particular manufacturer. But it makes a limit in certain fixed dimensions, and by having these certain dimensions fixed to absolute standard, there still is this opportunity for each individual firm to show what it can do on the given dimensions to make their particular fitting, whether it be a dynamo, whether it be a cleat, to make that, as every man tries to do, better than anybody else. But by having this particular system of absolute fixed dimensions of certain absolute points, if that can be done by this Society or by any other convention, I think a very long step forward will be made."

MR. WHEELER said the pump makers experienced a good deal of difficulty in trying to please customers. In the matter of nozzles, for instance, the Navy Bureau had a fixed standard, while many of the merchant yards had their own standards. It was difficult to adopt a standard, as advancement was being made all the time in internal improvements which necessitated a change in design. In this country what was good to-day was out of date to-morrow.

WALTER M. MCFARLAND said that in another society he was associated with Mr. Forbes as a member of a committee on standardization. Their experiences were very gratifying indeed, as the manufacturers were all eager for it. With that committee it was a question of getting the builders of engines and electric generators together on certain dimensions where their parts came together. There were only a few points about apparatus of this sort that would necessarily have to be made to a standard. All that would be necessary probably would be uniformity in flanges, in their diameter and distance from centers, and uniformity in the bolt holes, so that the machine could fastened down readily. All the other details could be made by each builder as he pleased. The reason that a standard was needed for this apparatus was not because the user wanted one particular make of pump built in that way, but that he would be able to make the pump seating, for instance, in such a way that it would not only fit this particular pump, but that if he had occasion to substitute for it another make of pump, it would fit equally well. The manufacturers with whom the committee conferred said that a standard system would save them a great deal of trouble, as they would not have to make so many patterns. The speaker believed that if the matter were handled right, a good deal of good might be accomplished.

MR. WHEELER said that as regards duplicating parts that was a system which he had adopted for many years, so that a piece could be taken out of stock and put into a pump and would fit exactly.

F. L. DU BOSQUE: "Bearing on what was said last by Mr. Wheeler and Mr. McFarland, I am very sorry to have to add testimony to the effect that pump people do not build to standards. We have lots of experience of that. If we break a piston of an ordinary 6-4-6 pump, it is necessary to build the piston almost from the foundation before we get a new one. That same principle carries through almost all the parts of pumps. Some time since we decided on a standard fire pump service on a different equipment. The pump given us at that time was very satisfactory. We kept ordering it from year to year, and probably eighteen months elapsed between subsequent orders, when we were told: 'We cannot build any more of this kind of fire pumps, we have to take the suction out on a different side.' The result was that half a dozen pumps we have in service are not interchangeable with pumps that we have to buy to-day. When we asked for the reason of taking the suction out of a different side, and not out of the end, they gave no other reason than that they had changed their patterns. These things are very annoying to consumers. I think that the interchangeability of parts has one advantage which is lost sight of in this discussion. I think it is one of the best insurances you can possibly have. Everybody knows if you are prepared to meet an emergency, that that emergency never happens. Our company has followed the plan of interchangeability to a very large extent. With a large equipment it is

necessary to do that. Break downs are occurring all the time, and you must keep in stock things to replace these break downs. I remember an instance illustrating the protection afforded by having spare parts. About six or seven years ago we had a very serious accident on one of the ferryboats, where a cylinder of an engine was entirely demolished, and to lay up a ferryboat is quite a costly item. One of the tugboats was sacrificed, brought to the shop, a cylinder taken out and put in the ferryboat, and inside of twenty hours the ferryboat proceeded on its way. It is only by strict interchangeability that such work can be done, and such economies effected. Appreciating that we might have the same trouble again, we ordered two cylinders, had them finished up, put one in a tug and the other in the shop. That was seven years ago, and the cylinder still remains in the shop. We keep on hand spare shafts, I might say six or seven pieces of shaft in our shop necessary for probably fifty or sixty boats. We sacrifice a little bit to weight in making a shaft a little too large for one fit in order to use the same size as used on another fit, and we find it pays very well to do it. So far as constructing machinery and engines standards, when made by different builders, I think that that has been worked satisfactorily in this way: We have probably ten separate engines of one class built in the last four years, and they have been built by four different shipbuilders, and I think that almost any part of any one engine will fit all the other engines, for the reason that at the beginning we insisted that all parts be made from the same patterns. That is, the patterns of the engines became our property; templets were made of the different fits at once, and the first engine was built from those patterns and templets. They have been subsequently sent to different ship yards, where engines have been built, so that the problem of building engines at different places is met in that way. There is no reason at all why interchangeability cannot be carried out, even in rather large designs. It is practically carried out by our people."

Naval Constructor Francis T. Bowles suggested that Mr. Forbes bring his paper to some practical purpose by making a suggestion as to how the work could be done, who would do it, and who would pay for it? It would take time and money to accomplish anything. He inquired if the government was going into this matter of standardization, and if so, in what manner it was to be done.

W. D. Forbes, in reply, said that he had entirely misunderstood the temper of the members. He had thought in preparing the paper that he was probably putting forward something that would not be wanted, but he was very much flattered to find that all the members seemed to be deeply interested in the question In answer to Mr. Bowles, he said he believed that the United States Navy should start this matter. It would cost money, but at the same time, it would save an immense amount of money. In many cases it would enable a ship to sail on time and sail in proper condition, where otherwise a large amount of work might have to be done at the dock. He suggested that the Navy start, for instance, in the matter of pumps, and referring to the committee upon which Mr. McFarland and the speaker were serving, he believed that when the standardization of electric generating systems was accomplished the Government would gladly take it up. He suggested further that a start might be made by the Navy in regard to the small launch engines, o that one could be substituted for another. Everyone recognized the value of interchangeability of parts, but in this case it was the *unit* that was under consideration. He wished this to be like a chair, which you could sit down on, no matter of what style or make, if you had the proper platform to put it on. He believed the Government should take the matter up and insist on certain standards, as had already been done in the case of flanges. He did not agree with Mr. Wheeler as to the difficulties that would be met, as anything could be changed when there was a reason for changing it; and in this case the reason would be that the manufacturers would want to sell their apparatus to the Government.

Mr. Bowles: "I had hoped to get a more explicit answer from Mr. Forbes. You know we read in the newspapers that the Government has trouble in agreeing with itself on a good many things. Now, if the Navy is to do this thing, there ought to be some means provided by which a responsible body can do it, and do it properly and do it effectively. It seems to me that, if the Society has taken this matter seriously, a memorial to Congress is the proper way to begin work, and I hope it will not stop with the discussion of this paper."

H. L. Des Anges believed that if a standard system could be devised for small units, it certainly ought to be extended to large units. The success of the application of such a system had been pointed out by Mr. DuBosque, and he believed that the trend of progress was in that direction. In the locomotive field the same difference existed some years ago as exist now in the marine field, and no doubt the same objections were then raised to standardization.

Col. Edwin A. Stevens said that in association with Mr. Forbes he had had in the past some correspondence and interviews with officials of the Bureau of Steam Engineering with a view to making the most important working parts of torpedo boat engines interchangeable. The difficulty at that time arose from the fact that there was no appropriation that could be used to fix the standard. If the connecting rods, piston rods, and shafts of a lot of torpedo boats, built under the same general requirements of law, were to be standardized, the dimensions, threads, diameters, distance of centers, etc., would require a set of gauges, which would be at least expensive. In building ten torpedo boats there would probably be some sixty-odd connecting rods and piston rods, and it would strike the ordinary manufacturer as a good investment to get his jigs and gauges ready and to build these parts interchangeably. If, as the Secretary suggested, the matter could be placed forcibly before Congress so that an appropriation would be available, there was no question that one item of standardization of parts of torpedo boats could be readily carried out. It seemed to the speaker that on account of the number of break downs in that type of craft, the standardization of such engine parts was as desirable as the standardization of electric units or pumps.

WALTER M. MCFARLAND said he did not agree with the suggestions of having the work done by the Navy Department or by memorial to Congress. It would hardly be possible by Act of Congress to compel manufacturers to agree on any standard. It would have to be a matter of mutual concession. A very much better way, the speaker believed, would be by the appointment of a suitable committee of the Society to take up the subject first and consider it on broad lines. It would be possible then to map out the best way to accomplish this work, and to get an agreement on something, even if it were only a few auxiliaries. If that much work could be done, it would be a help to others, and he believed that rapid progress could be made if the matter were taken up by a suitable committee composed of men of a conciliatory disposition, and at the same time with a firm purpose to carry the matter through.

"We would not want anybody who was a doctrinaire, or who had fixed ideas of what was to be done, but a man who was willing to hear the other side, and concede something himself. Have a committee composed of men of that sort, and I believe that in the course of a couple of years they would be able to bring forward a scheme which would meet with general approval on the part of the manufacturers, and if we found by that time that we had enough agreement to go to Congress, and to go to the Navy Department, and ask them to help the work along, I think we would be in good shape to do it. But if we start in the Navy Department, they, not knowing all the manufacturers peculiar features of equipment, might get up a system that would not fit in at all. Of course, they would consult the manufacturers. But if the committee should be composed of manufacturers, then we would have the very men who would know every point, and who could handle the subject very much better than people who are not."

E. PLATT STRATTON suggested as a first subject the determination of the thickness of flanges and the number of bolts for certain sizes of pipe. When this was agreed upon it would be easy for the representative sof the Society to arrive at a standard fitting, and after its adoption by the Society the classification associations could make use of it in their drawings. In this way the standards would be published far and wide, and would be within the reach of all manufacturers and engineers engaged in marine construction.

FRANCIS T. BOWLES inquired: "Would not the classification societies move in this matter initially acting acting under the advice of the Society?"

MR. STRATTON, in reply, said that the purpose of the classification societies was often misunderstood. They are the intermediary between the banker, the merchant, the shipowner, and the shipbuilder, and represent the capital side very largely of the operations in ships. They seldom take up anything more than necessity required. As they existed by no written law or operated under no written law except that of commerce and trade, it would be rather outside of their functions to dictate as to what sizes should be used as a standard.

W. D. FORBES said that it would be very difficult to make standards that all would adhere to, unless a law were passed to kill people who did not adhere to them. At the present time we had twelve threads and thirteen threads on a half-inch bolt. He believed this cost the engineering world a great many thousand dollars annually, but they still kept on doing it. He believed that the way out of it was for the Government to demand certain standards so that those who wanted to sell apparatus to the Government would have to conform to these standards.

PRESIDENT CLEMENT A. GRISCOM, in the chair, said that the subject was of particular interest to the shipowner. "We all try in our individual way to standardize everything possible and suceed to some extent. In our place we carry a large stock of spares which are interchangeable over a number of ships. When we design a new ship we try to adapt ourselves to what we already have in the way of standards. But the subject is a great deal broader than can possibly be carried out by individual practice, and I think the Society will have to let it lie over until it formulates some practical way of solving the question. I agree with Mr. Forbes that the Government should be a mother in this case and take all the tribulation, and tell us how to do it."

NAVAL CONSTRUCTOR JOSEPH H. LINNARD moved for the appointment of a committee of five to consider the whole subject of attaining the desired result of interchangeability of units, the committee to report at the next annual meeting any result that might be arrived at as to the proper method of accomplishing the end sought.

This motion was unanimously carried.

PERFORMANCE OF THE IMPERIAL RUSSIAN CRUISER VARIAG.

BY CHARLES H. CRAMP.

Commenting upon the performance of the *Variag*, the Author in opening says: "This high performance was due to the most perfect adaptation of her form or model to the attainment of the extraordinary speed required; to the excellent performance of her engines and boilers, and, also, to the best and most equitable arrangement of structural appliances in her hull to secure the greatest strength with least weights, and to the fact that in her design every pound of weight was put where it would do the most good." The vessel attained a speed of 24 knots over a ten-knot course, with 18,000 I. H. P., and a speed of 23.25 knots was maintained for 12 consecutive hours with a mean of 16,000 I. H. P. For purposes of comparison the Author has furnished a table showing dimensions, horse power, armament, complement and weights of the I. R. C. *Variag*, U. S. S. *Minneapolis* and *Olympia*, H. M. S. *Terrible* and *Diadem*, Chilian Cruiser *Blanco Encalada* and Brazilian Cruiser *25 de Mayo*. Points in favor of the *Variag* to which the Author calls attention are: "(1) No speed trial has hitherto been required of 12 hours' duration under natural draft. (2) Nothing approximating the speed developed by the *Variag* has ever before been attained in any vessel, or required by any contract to be effected under natural draft." In the contract for the construction of the *Variag* it was stipulated that the speed of 23 knots for 12 hours might be attained in two runs of six

hours each, with an interval between to rest the fire and engine room forces. In the trial this clause was not availed of, and the run was made continuously over the period of twelve hours. The performance of the *Variag* under the conditions imposed cannot be taken by the U. S. Government as a standard, the Author suggests, if there is adherence to "the scale of statutory limitations of cost hitherto incorporated in acts of Congress authorizing naval vessels. The Russions, while making drastic requirements, were also willing to pay the price necessary to obtain what they wanted." Commenting on the figures given in the tables, which accompany the paper, the Author points out that the displacement of the *Variag* devoted to coal and ordnance is extraordinarily high, amounting in the case of coal to 12 per cent of the displacement at trial draft. While keeping the fixed weights at a minimum in the construction of the vessel, it was also necessary to meet the Russian requirement that the maximum stresses did not exceed 5 tons per sq. in. of material—this requirement was carried out with a considerable margin. A water tight test was also imposed, each compartment being filled with a head of water equal to that which would be due to the immersion of the vessel to the upper deck line. This test was carried out to the satisfaction of the Russian inspectors. On trial the vertical vibrations of the hull, at varying speeds, were, at the maximum, very small, and under most conditions practically imperceptible. The dimensions, etc., of the *Variag* are: Length, on load line, 419 ft., 6 in.; beam extreme, 52 ft.; trial draft, 19 ft., 6 in.; trial displacement, 6,465 tons; indicated horse power, 15,925; trial speed, 23.25 knots; duration of trial, 12 hours; coal capacity, 1,250 tons; coal on trial, 770 tons; battery, twelve 6 in. R. F., twelve 75 mm R. F., six 47 mm, and two 37 mm, and two field guns; complement, 580; type of boilers, Niclausse water tube; type of engine, four cylinder triple expansion; number of screws, 2; fixed weights of hull, boiler and engines, 4,706 tons.

DISCUSSION.

Lewis Nixon said that the special interest of this paper lay in the fact that it contained some valuable data that would be of use in future designs. Most of the ships of this fast cruiser type that had been tried, especially abroad, had been tried on the measured mile, and, of course, there was a certain amount of jockeying in such trials. When a boat was tried, however, for a period of 12 hours it was absolutely impossible to follow out any jockeying at all. You had to get down to first principles, because the men had to fire the boilers and run the engines as if they expected to keep it up not only for 12 hours, but for 24 hours. Again, some of the data that had been accumulated was arrived at by means of what are called normal trial draughts. Such boats, after they had been appropriated by Congress to be of a certain displacement, were made so, but, really, in service they would average beyond that displacement; and a good many of the U. S. Naval vessels had been tried with weights insufficient to put them down to service conditions—the conditions under which the *Variag* was tried. The question of weight in this case was one where every advantage had been taken of the very best quality of material, such as the builders were able to get in the United States, and such material as, undoubtedly, enabled the American designer to go to greater length than the foreigner had been able to go up to this time. He believed, also, a large share of the success was attributable to the very careful study which had been given to the distribution of strains and the placing of material at such points as would do the most good. The *Variag*, he believed, had nowhere reached her limit speed. He was satisfied of this from the way she would answer a sudden increase of power, as she went over the course.

Naval Constructor Francis T. Bowles said that they all joined in thanking Mr. Cramp for laying before the Society the performance of the *Variag*, and the results were sufficient to awaken anyone to enthusiasm. Mr. Nixon had called attention to the information contained in the paper, which, he said, would be of use in designing, and that led the speaker to express the only thought he had in looking over the paper, "that for searchers for information the data is a little meagre." He said that they were accustomed to get more information in their papers than had been given in this instance, and he sincerely hoped that Mr. Cramp would see fit to add a complete set of plans and further data in detail.

THE UNITED STATES EXPERIMENTAL MODEL BASIN.

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

In this paper the Author gives information concerning details of operation and results obtained at the Washington tank which have not appeared in previous general descriptions of this experimental station. The paper is accompanied by many dimensioned drawings, plotted results of experiments, and photographs showing the various appliances used in the construction of models and in recording the experimental data. In commencement, the Author refers to the plans of the basin, which is located in the U. S. Navy Yard at Washington, D. C., close to the eastern branch of the Potomac River. The difficulties met with in the construction of the station, due chiefly to the presence of quicksand, have apparently been overcome, as there has been no trouble from leakage or settling. The basin has a capacity of about 1,000,000 gallons, and is filled with water from the city water supply. Before it reaches the basin this water is treated with alum which coagulates with any mud present, and it is then clarified by passing through a sand filter of the pressure type. The operation of filling occupies usually about a week. After filling the basin a small stream is kept constantly running through the filters to freshen the water and for make up. A 12 in. electrically driven centrifugal pump can drain the basin in 4 hours. Other pumps are fitted including a 4 in. centrifugal connected with troughs on each side of the basin at the surface, by which the water can be "scummed." A constant temperature slightly above that of a living room is maintained inside the station, so that persons on the moving carriage do not suffer any inconvenience when moved back and forth in the moist air. Wave disturbances, in operation are rapidly absorbed by the side troughs, and by a wooden wave breaker at one end

of the station. This permits trials to be run with comparatively short waits between each. The traveling carriage complete weighs 70,000 lb., and the maximum speed is about 20 knots, and this is developed in a run of about 200 ft. The Author gives an account of the method of electric speed controlling and of the hydraulic braking apparatus employed. With a pressure of 300 lb. per sq. in. the hydraulic friction brakes can bring the carriage to rest from maximum speed within less than 20 ft. The emergency brake on the principle of the hydraulic recoil brake for heavy guns, has never been tested, the other methods of braking being quite adequate. On account of the high summer temperature in Washington paraffin could not be used for models. White pine is used, and the Author makes a comparison between both substances, showing that on the whole wood is preferable. An advantage in its use was the possibility of using longer models than at foreign tanks. A model 20 ft. long is used. It was found that for the 20 ft. models of practically all the U. S. naval vessels, the resistances at the speeds corresponding to the actual maximum speeds of the vessels were below 40 lb., while with 12 ft. models the resistances would have been below 9 lb. With the large model the gap between model and full sized ship to be bridged by the law of comparison is less. In practice resistance curves are determined for each model of a warship, each extending somewhat beyond the speed corresponding to the maximum speed of the proposed vessel. In brief these curves are: (1) with a model corresponding to the normal displacement and trim, (2) the same model trimmed 4 in. by the head, (3) the same model trimmed 4 in. by the stern, (4) the same model 10 per cent lighter, (5) the same model 10 per cent heavier. In the drawings accompanying the paper the five curves for a model representing the U. S. S. *Yorktown* are plotted. The maximum speed of this vessel at 1,680 tons was 16.7 knots, and the corresponding speed of the model 4.93 knots. The Author directs attention to the plate showing curves of changes in level in the 20 ft. model when in motion. The net result of these changes is that the center of the model invariably settles when under way. As the speed increases the rate of settlement may diminish and a tendency to rise again may be developed, but in no case has this tendency been strong enough at maximum speed to really restore the center of the model to its original level. The fact, however, that a model at speed settles bodily with reference to its still water position does not necessarily imply greater immersion in the water, since the water level around the model is disturbed by the passage of the model. Results of experiments with models of the same weight, upon the same lines but with varying proportions of beam to draft go to strengthen the theory that length and displacement are the primary factors involved in resistance i. e., that given the length and displacement of vessels of usual forms, the resistance is not materially changed by practicable changes in shape, beam, draft, etc. To establish this theory, however, the Author says would require many additional experiments which it is hoped may be carried out in the future. An interesting result showing the practical (dollars and cents) value of the tank experiments in connection with observations on models of the *Georgia* class of battleships is referred to by the Author. These battleships will be among the largest and most powerful ever built or building for any navy. Experiment with different models of the proposed vessels showed that as between two particular models a slight change in shape and an increase in length gave a vessel which would attain the speed of 19 knots with 2,000 less horse power than the smaller vessel. The longer ship had about 4 per cent greater displacement than the other and yet gave the required speed on 19,000 I. H. P., as against 21,000 I. H. P. necessary to attain the same speed with the shorter vessel. Speed can be obtained by increase of length, the Author points out, but great length is objectionable in a battleship, involving, on a given displacement, heavier rudder gear for the same manœuvering capacity, a larger target, a greater weight of hull for the same strength, a greater weight of armor for the same percentage of protected area and usually somewhat greater power at the cruising speed of 10 knots. Therefore to determine by actual experiment the "necessary and sufficient length" of the proposed new ships was an achievement which would not have been possible but for the existence of the Washington experimental basin. Included in the paper are appendices containing details of the preparation of the models and a description of the recording dynamometer employed.

In the absence of the Author of this paper, it was read by Naval Constructor Washington L. Capps.

DISCUSSION.

After the reading of the paper had been concluded, ex-Engineer-in-Chief Charles H. Loring, U. S. N., who had been called to the chair, announced that it was open for discussion.

PROF. WILLIAM F. DURAND: "I wish to register my high appreciation of the extent of the information which has been given us in this paper, regarding the equipment of the Government tank at Washington, and of the very full manner in which the information so far available has been placed before us regarding the plant, which has been made ready for the purposes of experimental investigation. I am, perhaps, especially able to appreciate the work that has been done there, from the fact that during the past year or two I have myself been engaged in designing and building apparatus for carrying on similar work, although in a vastly more limited way. But I have had these problems forced upon me, and so have been concerned with attempting their solution, and this also somewhat on a more limited scale. One cannot help but admire the possibilities which are placed before the constructors of the Navy and the country at large by this magnificent equipment, and I wish again to register my high appreciation of the manner in which the design of the apparatus has been carried out, and its construction, and the careful way in which the various possibilities of the future have been provided for. I am sure that we as a nation ought to feel gratified that this plant has been provided, and that it has been placed in Washington in the charge of those in whom we may have perfect faith that they will be able to carry it on to its ultimate purpose, and that

finally the Department is so minded that it is willing to give out this extensive, exhaustive description of the plant and apparatus. I am sure we may confidentally hope that as the years go by we shall receive from this source of information a vast amount of facts which will be of the greatest aid, not only to designers of war ships and naval machinery, but to designers of mercantile machinery and to the country at large, and I am very sure that to the country at large the investment which the Government saw fit to make some few years ago for the establishment of this plant will be many, many times repaid."

Frank B. King said there were two or three matters which he believed were of very general interest in connection with the tank. He would like to have some information in regard to the outlook for the use of the tank by merchant shipbuilders or shipowners who were anxious to know something about the probable performance of ships of unusual design. He believed that, in connection with the Appropriation bill under which the tank was built, the Secretary of the Navy was authorized, in his discretion, to permit the use of the tank for private experiment. It would be of interest if Mr. Taylor would append to his paper a statement of the conditions under the which the tank might be used.

"The merchant shipbuilder is very often confronted with a vessel of unusual design," said Mr. King, "and he has to make propositions on vessels of unusual type at sometimes quite limited notice. Probably he will receive a communication in the morning, and he must have his general conclusions formed in regard to the possibility of attaining a certain speed in a vessel of unusual form or dimensions, and send off a proposal during that same day. Under these circumstances, it is almost impossible to properly estinate the power and the cost of the machinery, or of the modifications of dimensions which it would be most advantageous to make. It appears to me that this tank could be used, if there were time to permit it, outsde of the experiments carried on by the Government, to carry out a series of experiments on standard models of various dimensions, and preferably, I think, of extreme types or dimensions, from which, by Froude's law and the formulas that go with it, we could—having, say, 100 standard experiments to draw from—forecast with reasonable clearness, the probable performance of any vessel of extreme type."

Naval Constructor Joseph H. Linnard said that the Author of the paper, with characteristic modesty, had omitted to call the attention of the Society to the vast amount of original design and work involved in the model tank at Washington. He had the pleasure of following Mr. Taylor's ideas to an extent in the course of their conception and execution, and those who had made a study of the methods and equipment of foreign tanks had been struck by the fact that about the only thing common to the station at Washington and the foreign experimental stations was the fact that it contained a tank full of water. All the rest of the apparatus, was, he believed, absolutely original in design, and much more effective for accuracy, for power, and for rapidity of results to anything that had been accomplished abroad.

James Young, in a communication which was read at the meeting, said he found a lack of agreement in the statements made by the Author that "given the length and displacement of vessels of usual forms, the resistance is not materially changed by practicable changes in shape, beam, draft, etc.," and the statement, "our battleships, on account of the necessity for giving them shallow draught and rather full forms, are essentially harder to drive than the deeper draught foreign battleships of about the same displacement." If the first statement were correct, it would appear as if there were little use of an experimental tank. The case of the foreign battleship being easier to drive, due to the deeper draught, as the Author had mentioned, would show that her draught and form had something to do with her resistance, and this seemed to be explained by the fact that her prismatic coefficient was thereby reduced; or, in other words, that her length of entrance (by Kirk's analysis) was increased. This, he believed, played an important part in the resistance of ships, and if the Author had confined himself to the statement that "the length and displacement are important factors involved in the resistance of vessels," the writer would be thoroughly in accord with him. Mr. Young then outlined an arbitrary method which he had devised for determining the necessary I. H. P. required to propel a vessel at a given speed, "without any pretense of the true theory of the subject." He had been led to consider this matter by an investigation of the formula put forward by John Thom, published in the *Transactions of the Institution of Engineers and Shipbuilders in Scotland,* and he had endeavored to improve upon Mr. Thom's formula, by taking account of other factors and ratios of the vessel's form which had not been considered by Mr. Thom.

Naval Constructor W. L. Capps, in responding for the author of the paper, said that when the appropriation was made for the model tank, it was distinctly understood that, as opportunity offered, experiments with merchant vessels would be undertaken, but, as Mr. Taylor had stated, the staff was very much occupied with government work and that work would, undoubtedly, take precedence for some time to come. It was most probable, however, that the data derived from experiments with the government models would be at the disposition of the private shipyards, and in that way they would derive all the benefits from the work done. He did not think that it was at all possible that, when a question, such as Mr. King suggested, had to be answered in a few hours, it would be possible to supply any satisfactory experiments which would enable the estimator to complete his figures within twenty-four hours. The work on standard models would be carried out as far as possible as opportunity offered. Mr. Taylor had already started in this direction by expanding the U. S. S. *Yorktown* in various ways, to see what would be the result of a change in length, breadth and draught. He would like to add his own testimony to that of others as to the extreme value of the paper, and could state from personal experience that some of the matters contained in it, as derived from model experiments, were fully demonstrated in the full-sized vessels. With a bat-

tleship at seventeen and eighteen knots speed there was a very distinct settling at the stern and lifting at the bow, and with torpedo boats going at thirty knots, the change was even so great that you could see daylight between the keel forward and the water, and the level at the stern was some times just about level with the water forty feet away from the vessel. Undoubtedly, next year and in succeeding years, there would be much more valuable data to present to the Society, and, in time, he believed that the results would give the same sort of data that would be secured were merchant ships being tested in the tank.

JOHN C. KAFER referred to the experiments of Mr. Froude with the first model tank, and recalled an incident which occurred in the presence of Mr. Froude. After that scientist had been discussing the resistance of ships, one of his audience got up and narrated an instance of a ship having been lengthened, to carry six hundred tons more without increasing the resistance. In general, whenever a ship was lengthened the machinery was renewed and the economy was in the engine power. But in this case the machinery had not been altered at all, though the ship had been lengthened, and it was found that it did not require any more power to drive that ship at a certain speed than before the alterations, and yet she carried six hundred tons more freight. This had led Mr. Froude to make experiments with a model representing a ship 520 feet in length. This model was in sections and was towed in the tank, first entire, and then after sections representing 20 feet of length had been removed one at a time. Mr. Froude then found that the curve of resistance went up and down, verifying the results met with in the ship which had been lengthened. The true cause of this curious condition was not learned until some instantaneous photographs were made of the water. Then it was found that the wave generated by the bow of the ship was constant; that is, the ship's bow would generate a wave and a half. In one case, the ship took advantage of the crest of the wave being under the counter; but, in the other case, the hollow of the wave was under the counter. The speaker believed that Mr. Froude had gone into the matter rather exhaustively before he died, but yet had never been able to definitely say how long a ship should be made, or by what means the proper length could be determined for a given speed. He mentioned this little incident in connection with the experience of Mr. Taylor with the models of the *Georgia* class. He then referred to the tank in the ship yard at Dumbarton on the Clyde, which was the only tank in a private yard. He understood that the owners of the tank had on one occasion a contract for building an Australian steamship. They had been asked to build a ship from the drawings of a ship already in existence. They made a model of the proposed vessel, towed it in the tank and afterward mode certain changes in the model which brought down the horse power considerably, while carrying the same weight of freight and the same number of passengers, having, in fact, identical accommodations. The result of the experiment was a very large saving in cost of construction to the firm.

Second Technical Session.

Ex-Engineer-in-Chief Charles H. Loring, U. S. N., was in the chair when the members were called to order at 2:25 o'clock in the afternoon, and he announced the reading of the next paper on the programme.

THE COMPOSITION AND CLASSIFICATION OF PAINTS AND VARNISHES.

BY PROF. A. H. SABIN.

The limitations of chemical analysis as applied in general to paints and varnishes are noted by the Author by way of preface. A paint consists of a solid substance, a "pigment," mixed with a liquid which in the liquid state is termed the "vehicle" and when dry the "binder." The only white pigments are white lead and white zinc. "The simplest test of white lead is to put a little of it on a piece of charcoal and heat it in the reducing flame of a blow pipe; it will be converted into metallic lead and there will be no white residue." As little over 10 per cent adulteration may be proved in this way, the test for lime is more elaborate. Other common adulterants are barytes or barium sulphate, kaolin or white clay, whiting or pulverized chalk and silica. Of these, whiting, carbonate of lime, is alkaline and "should never be allowed in oil or varnish paints." Black pigments include lamp black and bone black—otherwise known as drop black and ivory black—and graphite. Lamp black is sold in various grades of fineness. It contains a peculiar oily matter and retards the drying of oil more than any other pigment but is the most durable paint. Red pigments include vermilion and carmine. Vermilion is a sulphide of mercury, of beautiful color and tolerably permanent. Carmine is an organic compound of alumina, is rather transparent, and is used as a finishing color. Coal tar dyes also furnish some red colors. Various iron oxides form the ordinary brownish-red and brown pigments; some are of a purple shade and all are deep in color and have great opacity. Many oxide pigments are made from ores containing clays, which make them brown, or, in the case of ochres, yellow. Sienna, used for staining wood mahogany color, is an earthy oxide. Chromate of lead, the most common yellow pigment, is made, in the paler shades, by the addition of sulphate of lead at the time of making the chromate. Pure orange chromate of lead is made by the addition of a solution of bichromate of potash to a solution of nitrate or acetate of lead. Cadmium yellow and ochre are two other yellow pigments. Chrome green is a compound of prussian blue and chromate of lead, and fades badly. Paris green is an arsenical compound of copper, brilliant but not opaque. Chrome oxide makes a subdued and permanent olive green. Prussian blue is a ferro-cyanide of iron, but the most common blue is ultramarine, a secret preparation. Cobalt blue is the most permanent, but too high priced for ordinary use. The foregoing are the principal opaque body colors, and there is in addition a class known as " lakes," made by precipitating the color ingredients of various dyestuffs with suitable chemicals. These lakes are commonly used to impart a tone to the more opaque pigments. Vehicles are next discussed by the Author. Linseed oil is the principal oil used, and

is made by expression from flaxseed "Crude oil" is allowed to settle in tanks and when clear is drawn off as " raw oil." "Boiled oil" is made by heating a portion of raw oil with lead and manganese oxides until union occurs, and then this is added to a large quantity of raw oil. Linseed oil, when spread in a thin film, absorbs and combines with oxygen from the air and is converted into a somewhat elastic, leathery substance known as linoxyn. "Dryers" are compounds of lead and manganese in solution in oil, and these metals when in linseed oil give up half their oxygen to the oil, and when exposed to the air—when the oil is spread out in a film—they absorb a fresh equivalent of oxygen, which again the oil takes from them, until finally the oil is converted into a solid, dry substance—hence the name dryers. Dryers are often cheapened by the use of resin or resin oil instead of linseed oil. "Japan" the Author defines as a substance which promotes the drying of a paint film. Dryers and japan shade into one another and what one now would call dryers another would call japan. In common acceptance japan is a liquid which by itself, dries to a hard film, and it often contains varnish resins. Another class of preparations termed japan includes varnishes that are fused on the surface of metals by subjecting the coated article to the heat of an oven. Cheap paints receive a share of the Author's attention. In these fish oil and mineral oil are often mixed with the linseed oil. Lime water, a solution of glue, and a solution of silicate of soda are also often used as adulterants. "Fire proof paints" are made by grinding into each gallon of paint about a pound of boric acid or a very soft and fusible glass, powdered. When the paint is exposed to heat the acid or glass will melt and form an air proof protective glaze over the painted surface. Most all oil paints contain turpentine, benzine or other volatile solvent. Kerosene is used as a substitute for turpentine, but should be avoided. "Varnishes" are divided into two classes: Spirit varnishes, including what are called "lacquers;" and oil-dried resin (also called oil-dried gum) varnishes. They are used as perservative and ornamental coatings by themselves, and also as vehicles with pigments making varnish paints or varnish enamels. A spirit varnish consists essentially in a solid substance dissolved in a volatile solvent, and when spread in a film the solvent evaporates and the permanent part is left as an enduring film. Spirit varnishes are made usually by dissolving shellac, or fossil resins in alcohol. "Compositions for ships' bottoms" are taken up by the Author at some length. These are made by dissolving coarse New Zealand resin in a mixture of coal tar, naphtha and benzine, and with this is mixed the pigment, which may contain piosonous matter, to make it an anti-fouling coating. A list of patents issued for ships' bottom paints is given by the Author, together with a chronological table of the application of various materials to this purpose. Bottom paints he classes as anti-corrosive and anti-fouling. The latter depend for their effectiveness upon some substance which will poison marine growths, such as oxides of copper, arsenical or mercury compounds. Discussing the use of these poisons, the Author states that the common practice has been to use mineral poisons; but in the end, organic poisons may prove more suitable. Oil paints have been used for ships' bottoms, but have not been satisfactory on account of the perishable nature of oil films in sea water Coating materials containing asphaltum in a volatile solvent are also touched upon. Oil-dried resin varnishes are considered at much length in the paper. These are made by dissolving vegetable resins in linseed oil, both being heated to a high temperature during the process. Varnishes of this class are also made by using asphaltum instead of resin, and these are especially adapted for use as baking japans or "enamels." Such enamels can be made without dryers and of the most refractory materials such as will resist any ordinary chemical action at high tempeatures. The Author believes that a properly made baked coating is superior to all others. "Red lead" is also considered in detail. It is a mixture of the peroxide and the protoxide of led, and is used as a paint, chiefly on iron and steel, to prevent corrosion. The most common adulterant is iron oxide. Its readiness to unite with other chemical substances make it, if directly exposed to the air or water, easily attacked, particularly by carbonic or sulphurous gases. The Author is of opinion that where red lead is used it should be with a maximum of lead to the given amount of oil, and that it should be used only as a first coat, being protected by two outer coats of some impervious paint or varnish. Attention is given by the Author to the common belief that varnishes are not suited to exterior use, for protection against the weather, whereas he shows that varnishes poperly made and properly applied are most effective for outside use. A varnish film is very much less porous than an oil film. The compound of oil and resin is far more indifferent to chemical action than oil alone. It also possesses a high degree of elasticity, and in this respect is vastly superior to a spirit varnish film which, when spread, is very brittle. For marine exposures the Author's experiments have conclusively shown that varnishes and varnish paints are greatly superior to oil paints or red lead, while the baked enamels are much better than either. "Fillers" are next considered, the Author expressing a preference for paste fillers over liquid fillers. In conclusion, the Author, as a result of his experiments, finds that in general there is no great difference in the value of pigments in either oil or varnish paints The thing most important is to have them ground fine—the finer the better. "The best pigment is a neutral, permanent, unchangeable substance, ground to the last degree of fineness, and mixed with the vehicle, whether oil or varnish, by grinding the mixture through a stone mill."

DISCUSSION.

BERNARD F. O'CONNOR, referring to the statement contained in the paper about paints for ships' bottoms, said that the point made by Professor Sabin regarding the ineffectiveness of oil paints on steel bottoms was not as well known among shipowners, especially those of the older class, as it should be. There was one point, however, upon which he disagreed with the Author of the paper. Professor Sabin had said that oil paints ,especially red lead and zinc, were a good foundation for what he termed varnish paints. In another part of the paper, however, the Author

said that nearly all of those so-called varnish paints had their own chemical affinities, and that some of them had a strong disinclination to affiliate with oil or oil paints, or that they might affiliate too closely and take the whole film off the ship's bottom. This was in connection with putting what are known as patent paints over red lead. In addition to the poisonous paints used for ships' bottoms, which the Author had mentioned, there was another class of paint in use in which the composition was such that, instead of poisoning the marine growths, it permitted them to catch hold of the surface, and then the first time that the vessel moved, the skin friction was sufficient to take off the growths—a sort of flowering paint. If this kind of anti-fouling paint could be made successful so that enough of it would remain on the ship to flower all over slowly, say for a year or two, it might solve the question. A curiosity of bottom paints was that the same paint on the same work would not act twice in the same way. This was due no doubt to the change of the chemical elements of the water in which the vessel might be, for as the Author had pointed out, sea water was a great solvent and a chemical agent of unknown but great power.

Professor Cecil H. Peabody inquired whether it could be definitely stated that the materials put in bottom paints, such as oxide of iron, copper and mercury, either one, or any, or all of them, were known to have a deletrious effect in promoting corrosion. Professor Loomis, who had investigated the subject, had dwelt specially on this point and was distinctly opposed to the use of copper in any bottom paints. He would also like to inquire whether the newer methods of making white lead gave a different product when finished and one less durable than lead made by the old process. He had been informed by painters that white lead made by the newer processes was likely to contain chemicals which acted upon the oil, and, therefore, the paint was less durable.

Prof. Sabin: "In regard to the matter of the action of the oxide in the metallic paint in the paint on a ships' bottom, it has been claimed that the use of powdered zinc is very advantageous, as it is well known that the zinc protects the iron as long as there is any zinc there. That is undoubtedly true so far as it goes. But as regards the action of the copper upon the bottom of the ship, I know that Prof. Loomis and others have objected to the use of copper in those paints. I am not myself a believer in copper paints, but I do not believer that there is any such action as he apprehended, because the varnish which is used is a perfect non-conductor, and as long as the varnish lasts it protects the paint, and as fast as the varnish goes off the copper drops off. That is the theory, and as a matter of experiment I do not believe it has ever been shown that copper paint does injuriously affect the bottom. That is my opinion in reagrd to the matter, and I have looked into it a good deal. It is the same thing with mercury. Mercury and iron do not have any affinities at all. We always distil mercury in an iron bottle, a metallic bottle, and even when it is so hot as to be in a state of vapor it has no action on the iron whatever, and I do not believe that mercury compounds affect the metal a bit. As to the white lead question, I believe that nine-tenths, perhaps ninety-five hundredths, of the white lead that is made to-day is made by the old Dutch process. There are one or two manufacturers who are making a different product and have got it on the market, of course, and you can buy it, and I do not know but that it is just as good. If have no reason to suppose that white lead is not just as good as it used to be. Of course, a painter always has an excuse for a paint not lasting. There is absolutely nothing more widely and uniformly distributed among mankind than the disposition to lay off the failure of anything on to your neighbor. I am not interested in the slightest degree in the white lead business, or any other pigment business, but that is my opinion, that the lead is practically just the same as it always was."

Prof. Peabody: "Can you kindly say what is your objection to copper? You say it probably has no effect on the plate. I don't know that that was mentioned in the paper."

Prof. Sabin: "No, it was not. I did not say officially. So far as I have been able to learn, it is not efficient; that is all. If it was efficient I would be in favor of it."

Prof. Peabody: "What would be more efficient?"

Prof. Sabin: "Well, I don't know."

Samuel L. Moore: "What makes the white lead fail? You say it is as good as it ever was."

Prof. Sabin: "Well, I can tell you. The principal thing that makes white lead fail is that they do not use oil with it. White lead will take less oil than any other pigment. Ordinary white lead is sold in a paste which contains ten pounds of linseed oil and ninety pounds of dry white lead. That is the regular standard formula. Now, there is no other pigment which you can make a paste of with oil, without taking at least twice as much oil as that and usually more. To make an ordinary paint, that is, paint thinned down to the ordinary consistency with white lead, you take less oil than you do with any other pigment. The painter wants his paint to dry very quickly. If he puts a lot of dryer into it—he always puts in some—he is sure to darken the color and yellow the paint. Now, the beauty of white lead is that it is white,, and so that instead of putting a dryer in, which I do not believe in, anyway, he puts in turpentine; he thins down his paint with turpentine, and the result is that the turpentine evaporates, and in his film he hasn't got enough binder, he hasn't got enough cementing material there to hold that lead together, and it just comes off. If he would use straight oil the paint would not dry quite so quickly, but it would be durable, and that is the primary and fundamental objection to this whole white lead business; it is because the painter uses turpentine to thin down with, instead of oil."

Mr. Moore: "Supposing a man buys white lead and boiled oil, and mixes them himself, it doesn't last any better."

Prof. Sabin: "He ought to get good results. Some years ago we were selling a lot of dryer to a man who was making an artificial linseed oil, what he called 'Cuban linseed oil.' He went into bankruptcy and I had occasion to go through his books, and I

found the secrets of the trade. He was making that oil out of what is termed 'neutral,' which is a product sold by the Standard Oil Company. It was sold at that time for twelve and a half cents a gallon. It is an oil of about the same consistency and color as linseed oil. He loaded that stuff up with resin and dryers. It is an astonishing thing, but it did dry quite a good deal. Now he did not sell that oil to the consumer, but he sold it in carload lots to the jobbers, big people, with first-class business reputations, and that oil went into boiled linseed oil. It did not go into raw oil, because it was full of dryers. Now, there is a lot of adulterated boiled oil sold in the market, so much so that we have now got stringent laws in this state against it, and the State Commissioner of Agriculture has employed a chemist and is going at this thing to try to put a stop to it if possible. But it is extremely common. The extent to which adulteration is carried out is something which anybody who is not in the trade can have no idea of."

Mr. Moore said that he was acquainted with a man in the paint business who used three ingredients—water, oil and sugar of lead. He believed that in this case the sugar of lead was used to make the water and oil mix. In his own experience he had found that you could mix linseed oil and water in ordinary paint and they would not separate.

Prof. Sabin said that the sugar of lead used in the mixture referred to was used probably as a dryer, but it was not likely that much of this chemical would be used, as it was very expensive. The paintmaker referred to probably used a great deal of water. By the use of lime water, dilute soda solution, or borax and water, a mixture with oil and pigment could be made and many of the mixed paints sold were manufactured in this way. "You can run right along down all the way from a pure linseed oil paint to a kalsomine. Kalsomine does not contain any oil."

George M. Gardiner: "I would like to supplement a little what Prof. Sabin said in reference to copper in paints. I have probably had as much experience in these matters as anyone else, having been the original introducer of copper paint for wooden vessels in this country. Of course, copper in the way that we manufacture it for copper paints, and copper oxide pulverized, would not do to come in contact with the iron or steel. It was manufactured in those days simply for wooden vessels to prevent fouling, and especially prevent attack by the teredo, and it was very efficacious, so much so that insurance companies, on short voyages, would insure wooden vessels coated with copper paint on the same terms that they would a vessel with a metal bottom. That composition would not do on iron, except when it had some material between to protect the iron from the action of the copper paint. It became necessary, as the building of iron ships increased, to have a composition that would not only preserve the vessel from fouling and protect the iron surface from oxidation, but would also be a smooth coating. I devoted a great deal of attention some years ago to coating the bottoms of yachts to see how I could get the greatest amount of speed out of them, first, as a sort of fad, and then as regular practice, but I found the English people had gotten rather ahead of me, and were making a soap paint that exfoliated and in a measure hermetically sealed the iron or steel under it, and gave very excellent results. As to the copper attacking the iron or steel in any way, I would say that recently I examined a ship for some of the underwriters' agents here in New York, a ship that had been coated in this way for some twenty-six years, and the hammer marks on the rivets were as plainly discernible as if she were a new ship. The butts were all intact, showing absolutely no deterioration whatever. I have experimented extensively with all the poisonous compositions, the metallic oxides and some of the organic poisons, most of them, and I have examined in my time something over fifteen thousand vessels, and the difficulty in having any literature on the matter has been the difficulty in experimenting properly, the difficulty of getting hold of ships that had been coated and seeing them when they are docked. They are docked, of course, without any warning, and it is not possible to examine them and see them painted, and then have a vessel go away again and see it when it comes back, have it make various voyages to different parts of the world and of different durations, and all that sort of thing. Most of the people who have been interested in the subject have had a composition of their own, and all the benefits they could get from their experience they wanted to use in a commercial way for their own profit, so that it has been very difficult to get any really authentic data as to the action of various compositions on vessels' bottoms. We have been obliged to simply get the different compositions made in different portions of the world and make practical tests with them as best we could. I have done that whereever it was possible for the past thirty-five years, and the best composition that we have found so far is the metallic soap. Varnish paints are more soluble in water, and affected by the friction, the attrition in passage through the water. In the case of torpedo boats that make great speed the compositions are washed off very rapidly indeed. I remember Captain Fremont telling me that by looking over the bow of the *Porter* when she was going at her top speed, he could see the paint disappear. She was coated five times, I think, in six or seven months. The mercury poisons are more readily dissolved, as the Author says, in the water, and they are very much more injurious than any of the other organic or mineral poisons, when used as paints on iron or steel, especially on steel. But it is a matter of a good deal of importance to get a composition that can be applied in all sorts of weather. A vessel goes into the dry dock, it is frequently necessary to paint it the same day. I have to-day a large steamer on a dry dock ready for the workmen at two o'clock, and she has got to be completed to-night, painted three coats and ready to go in the water to-morrow morning. A member has remarked that the same paint sometimes does not act in the same way. That results frequently from the manner in which the composition is applied and to the length of time that the vessel is in the water, where she goes, and all that sort of thing. The water varies in different parts of the globe. You may get in one place a water that contains certain con-

stituents and in another place altogether different constituents. You will find in the Mediterranean that the water is altogether different from the water outside, and that is one of the reasons for the apparent difference in the action of the different compositions in different waters."

Naval Constructor Francis T. Bowles: "There are certain things that everyone in the ship business knows about paints, and particularly about bottom paints. We know that they are all very expensive and none of them very good. Now, most of the knowledge upon this subject is confined to the people who manufacture the paints, and as you have seen to-day they keep that strictly to themselves. I had hoped that by the inducement of Prof. Sabin's very valuable paper these gentlemen representing the bottom paints would have been moved to give us a little more information. It is, however, necessary that this subject should be followed up in a systematic way, and I have some pleasure in telling you that Prof. Sabin is carrying on a systematic series of experiments which have already extended more than two years upon all kinds and varieties of paints, to their action in sea water, and if he persists in this investigation, which he undaubtedly will, then we shall in the course of a few years obtain certain actual facts which will lead to the improvement of bottom paints for steel vessels, a subject of the very greatest importance to us all."

Mr. Moore said that he had often noticed that the mill marks on plates which were put on with a mixture of white lead and turpentine never wore off. He believed that every man who had docked ships would agree with him that when a ship was hauled out and cleaned and scraped, the mill marks would be found on the plates. Even in the case of plates that had been pickled, he observed that these marks remained on. They were applied when the plates were hot.

H. L. Des Anges narrated a similar experience. He had often in renewing plates on a vessel's side noticed that the original mill marks were still quite legible, while the rest of a plate was very badly corroded.

Mr. Moore related an experience with pulleys on which the size had been painted with either white lead and turpentine or lamp black and turpentine. These pulleys had stood out of doors for years, and when brought into the shop the markings could be easily wiped off, but the figures—the place that the paint had protected—stood right out in relief, while the surrounding metal had all rusted and pitted badly.

Naval Constructor Lloyd Bankson, in written discussion, said that the French Naval Constructors held that galvanic action took place between lead paint and the steel hull of a vessel under water. He quoted Dr. Dudley of the Pennsylvania R. R. to the effect that "the most persistently active rust producing agents, carbonic acid and moisture, were generated in the drying of linseed oil; and, further, ordinary rust (hydrated oxide of iron often containing more or less carbonate of iron) is credited by chemists with imparting to the metallic iron immediately under it some of its oxygen and water, and replacing this loss from the atmosphere, or from any other available source, acting as a carrier of the necessary elements; 'rust begetting rust.'" According to the statement that carbonic acid and moisture are generated in the drying of linseed oil, it was quite possible that galvanic action set up between metallic paint and the surface of steel hull under water, which also set free, possibly, a certain amount of oxygen from the water. Those who had examined the bottoms of vessels in dry dock immediately after pumping out might have noticed blisters filled with water, with small rust spots underneath, showing probably incipient formation of pits. It was also possible that the spongy condition of any of the linseed oil paints would admit water at certain points between the coating of paint and the hull of the vessel. These conditions, he believed, would account in a great measure for the pitting of steel vessels. He then referred to torpedo boats built and building at the Bath Iron Works, on which a neutral paint known as "Zinc Gray" had been used to protect the hulls, and especially for protecting the aluminum, which was extensively used in certain parts of the hulls of the boats referred to. The torpedo boat *T. A. M. Craven* was painted entirely on the outside above the water line with a dark brown neutral varnish, and no criticism had been made in regard to the visibility of this boat so far as the color was concerned. This coating was lighter in weight than lead paint, and made a very efficient coating for all metal work above the water line, and for all metal work inside. In consequence of the apparent deleterious action of metallic paints, such as red lead, etc., on steel vessels below the water line outside, it was probable an excellent coating for ships' bottoms would be a first coat of a water tight neutral varnish, upon which might be laid a good, quick drying, anti-fouling paint. He believed that this was an experiment well worth trying.

TESTS OF THE ELECTRIC PLANTS OF THE BATTLESHIPS KEARSARGE & KENTUCKY.

BY NAVAL CONSTRUCTOR J. J. WOODWARD, U. S. N.

This paper is supplementary to the paper descriptive of the plants on these ships, which was prepared by the Author for the previous meeting of the Society. It consists of a series of plates, containing tabulated and graphic results, of exhaustive tests of the electrical plants of the two battleships built at the Newport News Yard. The text which accompanies these plates simply explains the results sought in each case, and the methods by which these results were obtained. The tests, which were nominally in charge of the Author, were carried out in his absence abroad by his assistant, J. J. Crain, M.E., who had charge of the work from its inception. In general the object of the tests was, first, to determine if all appliances used were properly constructed and installed, so that they could perform in a satisfactory manner the severest duty that would be required of them in actual service and, second, to collect quantitative data regarding the performance of these appliances. An auxiliary of each of the kinds installed was given a "type test" in which it was run under all possible conditions of load, speed, length of run, etc., and a record of all data obtained was made. This was followed by an "acceptance test" of all other auxiliaries of the same kind, which consisted of

only of such running as was necessary to show that the auxiliaries were operating in practically the same manner as the individual machine which had been given the more exhaustive type test. Any characteristic fault in design or construction would be developed in the type test, and in such case the test was discontinued until the fault was remedied. The acceptance tests developed any local faults of installation or material. The foregoing system was adopted for all motor driven auxiliaries, but for generating sets a different method was pursued. The object of the tests of generating sets was to demonstrate that each set would run satisfactorily for a continuous period of forty-eight hours, and to determine the total steam consumption of the electrical plant under varying conditions of load. In the endurance test the load consisted of the ship's lights and ventilating motors, and an adjustable water rheostat located on the upper deck. This rheostat was manipulated from the dynamo room and the load was kept constant on each generating set during the run. During twelve hours of each forty-eight hour run a boiler test was made on the auxiliary boiler used, and during six hours of each boiler test the engines were indicated and the output of the generators simultaneously measured. The general scheme for the determination of steam consumption was to measure the total water fed to the boiler, and then subtract from it the steam used to run the boiler feed pumps, the auxiliary condenser, air, and circulating pumps, the steam condensed in the steam piping, and that used by the calorimeter, the remainder being the steam consumed by the engines of the generating sets. The auxiliaries tested included those for operating the turrets, boat cranes, deck winches, ammunition hoists, elevators, blowers and exhausters. A summary of weights of the electric plant is also included. In ascertaining the weights the electrical appliances were separated from the mechanical parts operated by them—the motor pinion used was the dividing line. All gearing beyond the motor pinion was classed with mechanical parts, and the total weight of the electric outfit for each ship figured out 201.53 tons.

DISCUSSION.

J. W. KELLOGG: "I would like to recall the discussion last year of the paper in which Mr. Woodward gave a description of those plants, and promised the results of tests for this year. At that time one turn the discussion took was the question of the economy of the electrical auxiliary and the steam consumption that could be expected from any auxiliaries, the average steam consumption, in comparison with the small steam engine. By taking the figures as given in this paper I find that the steam consumption of the generator set is 34 pounds per kilowatt output at full load; 37 pounds at three-quarter load, and 49 pounds at half load. The average efficiency of the motors is 75 to 80 per cent full load, and 69 to 74 per cent half load. The blowers, including the line loss, show 85 per cent efficiency. The blower load is the steady load, and is the one which is the most apt to be on, I think, of any of the auxiliaries where electricity is at present employed. Taking that efficiency and the steam consumption of the generating set, the consumption at the motor would be 30 pounds per horse-power at full load, and 33 pounds per horse-power at three-quarter load, and 43 1-2 pounds at half load. I think the statement last year was that the economy would be about 40 pounds as an average for all motor driven auxiliaries. I think that the results of this paper bear this statement out. I also wish to call attention to the pipe condensation as shown for the generating sets. It varies from 8 to 15 per cent of the steam used in the engines of the generating sets. I think the condensation in the piping throughout the ship, carrying steam to the other auxiliaries, would be about as large as this, and if it was added to the consumption of the ordinary steam engine—small engines driving the auxiliaries on a ship—the steam used per brake horse-power would be found to be at least double that of the average for electricity."

THE COALING OF THE U. S. S. MASSACHUSETTS AT SEA.

BY SPENCER MILLER.

This paper is supplementary to a paper entitled "Coaling Vessels at Sea," that was presented by the Author at the 1899 meeting of the Society, and in which he described the form of apparatus he had designed and which was then awaiting trial by the U. S. naval authorities. Since that time a practical test of the apparatus has been made in coaling the U. S. S. *Massachusetts* at sea. The apparatus tested is the same as that described a year ago, excepting the addition of an auxiliary or tension line above the conveyor lines, and a sea anchor attached to the end of this line. The dimensions of this sea anchor depend upon the speed at which the vessel coaling is moving. The apparatus had five trials. On the first day adjustments were made and nine loads passed between the collier *Marcellus* and the battleship. On the second day more adjustments were made and a run of 38 loads in 38 minutes and 40 seconds was suddenly terminated by lack of skill on the part of the operator. On the third day in one hour the apparatus transferred about 22 tons. The fourth trial was an endurance test of four hours. In 3 hours and 43 minutes 75 tons was handled. The water was smooth with a ground swell. In the fifth test—rough weather trial—80 trips were made in 80 minutes. In this trial one hour and a half was consumed in securing the tow line and setting up the apparatus. The boats steered at first head on to the sea. The forecastle of the *Massachusetts* was washed at every plunge, and no coal could have been delivered there even if desired. A little more than 20 tons were handled in an hour. The course was then changed, quartering on the sea, and the results were the same. Then the boats steered in the trough of the sea, and a rolling of 7 degrees did not affect the working. The speed was maintained at about 5 knots, and during the trial the *Massachusetts* burned about 3 1-2 tons of coal per hour. At 300 feet distance between the ships, even in smooth water, the collier followed badly, and when over 7 degrees out of her course the operation was stopped. In spite of stops, however, 20 tons per hour was delivered. During the rough weather trial, and with about 400 feet between the ships, the collier followed perfectly and no time was lost. In discussing possible improvements, the

Author suggests the use of a tension engine instead of a sea anchor, as in the case of the latter the strain on the line is very variable, due chiefly to the motion of the vessels in a seaway. Forty tons an hour could be readily loaded, he believes, by increasing the separate loads to 1,500 pounds. The paper closes with an excerpt from an article by Rear Admiral Royal B. Bradford, published in the *Forum*, in which that writer advances the self-evident proposition that coal is needed to enable steam war vessels to keep the sea.

DISCUSSION.

Captain Charles J. Train, U. S. N.: "I am very glad to be present at this time, because I was not prejudiced, originally, in favor to towing this collier with the strange device of Mr. Miller, but the success of the invention was so great, everything turned out so well, that I am very glad to say that my prejudices were entirely removed. The towing of a ship by a man-of-war is always unpleasant. A towed ship means disaster and trouble and all that sort of thing. It never occurred to any of us—to me, certainly—that I could tow a ship at 300 feet distance, and run a trolley over it in twenty seconds from ship to ship with perfect certainty and accuracy, as we did. The coal came up that elevator on the collier with unexampled speed, hooked on the carriage, came over to the *Massachusetts*, and came down our hatchway with just as much certainty as it is carried in by the colored women down at Santa Lucia. Whether the suggestion of the English Admiral that the operating of machinery should be placed on the war ship is possible or not, I am not at all sure. The handling of these winches requires trained men and expert men. We have not got them on board ship and we cannot have them, and I am not at all in favor of fitting up battleships with such winches as those Mr. Miller requires, particularly the winch which is necessary to take the place of the sea anchor. Unquestionably the sea anchor was the key to the whole situation, not that I knew it before, because I did not know how far the art of carrying materials from place to place by means of trolleys had gone I had never heard of any such thing as a slipping drum. But the sea anchor made it advisable, and it required Mr. Miller's presence on board the *Marcellus* to see how the towed ship was constantly shooting from side to side and the difficulties in towing ships. So that without the sea anchor he never could have handled that trolley. That the sea anchor could have been replaced by a better device, I am perfectly confident, but that men-of-war could be so arranged I do not think is possible. We have already more machinery than we want, more machinery than we can handle with the men at our disposal, and I certainly believe that the colliers themselves should be fitted up with this contrivance, and that the American Navy should have 5,000 ton or 6,000 ton colliers fitted out with this contrivance by means of which they are independent of any coaling station, which, of course, are points of weakness that would only fall into the hands of the nearest strong navy. However, that is not material to the subject. All I want to say is that Mr. Miller's invention makes coaling at sea a perfectly feasible, simple, easy operation, which it never was before."

Naval Constructor Francis T. Bowles said: "I do not think it is safe for us to be always guided by the opinions of the English. I certainly hope that all the English battleships will have Mr. Miller's device, but I am equally hopeful that ours will not. Captain Train has put the matter very clearly, that we are already overloaded with machinery, and I can see that to carry this device on board a battleship would require a number of important changes in things that we now have located in more or less essential places. Our circumstances are somewhat different from those of the English, and it seems to me that we could afford to have colliers suitable in size and character for our work, fitted with devices for coaling at sea, and thereby have somewhat the advantage in the efficiency of our battleships."

Naval Constructor J. J. Woodward: "There is one point in connection with the installation of these special winches on colliers that I think is worthy of attention, and that is that quite apart from the manifest advantages of having special vessels fitted as colliers, ready at any time for service, has been really the perfection of the detail in the design of the winch. If we had these appliances at our Navy Yards, so that it would be simply necessary to place them on vessels suitable for carrying coal, the time required to install them on the colliers could be made very slight, indeed, provided always that the installation was on hand. The somewhat varied foreign policy that we at present have, the importance of having coal, and the means of getting coaling stations in an effective condition whenever we may be called upon to need them, gives to this general matter of coaling at sea a special importance. Any one who has had any experience in attempting to coal one vessel from another in a seaway, with two vessels alongside of each other, cannot fail, I think, to realize that the endeavor to coal in that manner is practically an impossibility."

Spencer Miller, in reply to the criticisms about adding to the complexity of the machinery already carried on war vessels, said that he hoped before long to devise some way of putting the necessary machinery on the war ship without adding anything to the complications. If he was unable to do this he would acknowledge that he was beaten.

Third Technical Session.

The meeting was brought to order on Friday morning, November 16, at 10:30 o'clock, by Charles H. Cramp, who occupied the chair. He called for the reading of the next paper.

NOTES ON RECENT IMPROVEMENTS IN FOREIGN SHIPBUILDING PLANTS.

BY ASSISTANT CONSTRUCTOR H. G. GILLMOR, U. S. N.

This paper is the result of personal observations made during visits to foreign yards during the years 1891-94 as compared with those made during recent visits in the years 1898-1900. The Author opens with the statement that "among foreign shipbuilders, as among other manufacturers with whom America is in competition, the impression seems to be general that American plants and American tools are as far in

advance as those of any country in the world. He refers to the fact that one shipbuilding plant looks very much like another, "at first sight," whether the plant be in America or England or elsewhere. "It is possible, in shipbuilding, to do with plant of value proportionately so small, as compared with the value of the product output, that often the plant is almost forgotton in the interest in the work being done." Most plants have developed from modest beginnings, their arrangements in the first instance being dictated by the character of the ground and the means at command. In expanding, the best results have been considered, but it is not always possible to use space to such advantage as would be the case were the plant originally laid out on an extensive scale. In many cases the increasing size of vessels has made rearrangement an absolute necessity, and in such case the work shops have been brought as near as practicable to the ships and an effort made to have material follow a regular course, with the minimum of handling. In connection with the arrangement of plants the author touches on the Trades Union question, which is "nowhere more to be seen than in the development of shipbuilding plants in England, and practically all the steel work is paid for by the piece, and the resistance of the Boiler Makers' Society (a combination of all steel and iron workers in the ship and boiler trades) to all reductions in piece prices is so great that it is impracticable to secure any adequate reducton in the labor costs from improved facilities." Improved facilities seldom give the builder even an increase of output, as broken time increases with every possible increase of earnings of the skilled labor. In the opinion of the Author, many English builders would have carried out extensive improvements had not conditions been such that no adequate return on the investment was possible. Trades Unionism is not so powerful in Germany, and partly for this reason, and because yards are newer, better arrangements and more labor saving appliances are to be found there. Next, the Author refers to the great waste of power in the average yard ten or twelve years ago, due to the extensive use then of isolated steam engines supplied from central boiler plants, and there have been extensive changes in this direction, largely in the direction of substituting for the steam plant gas and oil engines and electric motors. In one important yard steam has practically disappeared, except for hydraulic pumps and the yard locomotives. With gas engines, municipal gas, sold at a reduced rate, is frequently used, and in many cases Dowson or other fuel gas generated by similar processes is used. The engines employed are usually single cylinder, single acting, working on the Otto cycle. They are used generally for driving the machinery in the various shops, though not for direct driving of isolated machines. The gas engine is not adapted to the direct driving of the several heavy machines, subject to more or less intermittent working, which have a prominent place in the ship yard. For this reason extensive use is made of the electric drive. Dynamos of various types are employed, usually direct current machines working at about 110 volts. These supply current for both light and power, and are driven, in central stations, by both steam and gas engines, steam engines usually. Electric motors are extensively used for driving the heavy machines direct, and they stand hard service without failure, and usually have often no other protection from the weather than that afforded by a light wooden cover with perforated metal ends. The care of the motors and wiring is usually in the hands of men or apprentices who could not be classed as electrical experts. Hydraulic power is invariably used where large vessels are built, for heavy flanging machines, manhole presses, and cranes. With two notable exceptions there has been little recent improvement in appliances for handling materials in the shop. This is due to the reasons already mentioned, which make it impossible to reduce costs by the installation of labor saving devices. The old method of having wooden derricks along the sides of the building slips is usually adhered to, and light locomotive cranes for handling cars in the yard and for transporting heavy materials are frequently met with. Standard ship yard tools have not changed much except in size to handle the increased size of scantlings. In Germany the power bevelling machine (an English invention) is in general use, while in England the joggling machine is commonly met with. An ingenious plate scarphing machine, also new styles of plate drilling and countersinking machines, rolls and other tools, were noticed by the Author. In the fitting (machine) and joiner shops improved tools, many of American make, are numerous. In many yards much work which would be done in the fitting shops is let out to concerns making a specialty of such work. In the employment of portable tools at the ship very little has been done. Many portable electrical drilling and counter-sinking machines are in use, even in yards which do not employ electricity for other purposes. Portable hydraulic riveters are used to an extent in the frames, floors and longitudinals, at the building slip, but portable pneumatic tools, though met with in boiler shops, have been adopted to a very limited extent in foreign ship yards.

When the Author had finished reading the paper the Chair announced that the next paper on the programme would be immediately read so that the discussion could be had upon both papers together.

CAN THE AMERICAN SHIPBUILDER UNDER PRESENT CONDITIONS COMPETE WITH THE BRITISH AND GERMAN SHIPBUILDERS IN THE PRODUCTION OF THE LARGEST CLASS OF OCEAN PASSENGER AND FREIGHT STEAMSHIPS?

BY GEO. W. DICKIE.

In opening, the Author explains that this paper is written in the light of a visit to British and Continental ship yards, and on board of the S. S. *Saxonia* upon his return trip. This type of ship, he believes, represents a higher degree of skill in naval architecture than

the type in which everything is subordinated to speed. This type, indeed, will become the most important in the future extension of American shipping. The *Saxonia* carries 9,000 tons of freight at 15 1-2 knots on a coal consumption of 145 tons a day, or 1,200 tons of fuel are used to carry 9,000 tons of cargo across the Atlantic at a speed that secures a large passenger patronage. The secret of this result is, first, the great increase in size of ship, and second, fitting engines of just the size required for the speed. The old idea of having a large surplus of engine and boiler power is discarded. Present results are also had through increased efficiency of engines and boilers. In answering the question contained in the title of the paper, the Author has endeavored to make a comparison, separately, with the three factors that enter into production-skill in design, cost of labor and cost of material. In merchant work skill in design must have the commercial element as a prominent factor, and must embrace both the financial interests of the shipbuilder and the shipowner. In order to prevent these interests from injuriously affecting the interests of the shipper who furnishes the cargo, and the interests of the underwriter, who insures both shipowner and shipper, the classification societies exist. These so hedge the designer about with rules as to leave a very narrow field for the exercise of his skill. Yet narrow as this field is the progressive shipbuilders of Europe are continually pushing out the barriers, and forcing the recognition by the societies of new methods, new properties, and new combinations that have transformed not only the dimensions of vessels as now built, but methods of construction also. Continuing, the Author says that while stating these obstacles that confront the naval architect, he does not set them down as opposed to progress, "but as limitations to the free exercise of the skill in design that many naval architects, and especially those of America, think they possess." The first impression of the ambitious young naval architect, in regard to Lloyd's rules, for example, is that they are opposed to all progress, but later experience usually modifies this impression. The Author then bears testimony in his own experience to the skill of Lloyd's surveyors, but expresses the belief "that an American register of shipping that would be accepted by the shipowners and by underwriters the world over, would be a great help to the American shipbuilder, as it would no doubt lend itself more readily to the tendencies of American design. The British ship is the result of British experience, gained by British shipowners and sailors, embodied in British designs by the British naval architect, finally taking form in British ship yards; the result carrying with it much of the traditions and practice of the people and place where the work is done." He asks the question: "Now can we in America do better than this?" and adds tha we are likely to work out the problem on our own lines, in which a closer adaptation of material used to its place and function, in the complete design, will be found. The steel maker will help in this, for as he becomes better acquainted with the special needs of vessel construction he will be ready to undertake new sections, better adapted to the strains and stresses of ship structure and reducing built up work to a minimum. In this point we are now abreast of the British builder, and in methods of handling material ahead of most of them. In some of the ship yards of Europe, says the Author, a greater experience has been acquired in the production of the largest ocean steamships, both for passengers and freight, but we are in the way to obtain this experience which will come, as it has come to those abroad, by a steady and skillful application of what has already been done. Among the younger naval architects in Britain, especially, the Author found a belief that the United States is to be in the near future, "a rich field for the practice of their profession." As to the cost of labor. In Britain the whole steel work of a ship is done under the piece work system, the price per unit being fixed for certain shipbuilding districts by agreement between the builders and trades unions. This method simplifies estimating, as a certain known portion of the work has a certain fixed value. On this side, while piece work is very general, there is no uniformity in the methods of fixing prices. In British yards, as here also, the number of men on wages, on work supposed to be done by piece, is greater than that of the piece workers. The management aims to reduce the number of men on wages as compared to the number on piece work. On an average steel work in British yards costs from £3.17.0 to £4.0.0 a ton of material worked. This can about be equalled here, the Author declares. In fitting out, however, including carpenter and joiner work, painting and general finish, where piece work does not cut any figure, the cost is directly as the wages paid. American yards pay 50 per cent more wages to this class of men, and consequently the cost of labor that is reckoned in wages will be 50 per cent greater in the American than in the British yard. If half the labor cost for any given ship, built in a British yard, is paid in wages—the Author believes this is nearly correct—and that half costs 50 per cent less than the corresponding part in American yards, the total labor cost here will be 25 per cent greater than theirs. In American yards, however, while higher wages are paid the office staff of draftsmen, this part of the work does not cost any more than in British yards, as a like quantity of work can be done here with fewer men. Members of the managing staff are paid less on this side and devote much more time to their duties. The solution of the labor problem, says the Author, will be found not in an equalization of the rate of wages paid throughout the shipbuilding world, but by some method whereby every part of a ship will have a labor value fixed for it, and the workmen will receive as compensation the percentage that his labor represents of the total labor required for the particular piece of work. This system is now carried out successfully in prosperous machine shops in England. In Britain, marine engines and boilers cost less in proportion to hulls than here. Machinists and boiler makers receive about 50 per cent more wages on this side. In small tools our works are better equipped, but in large tools are no better off. The Author refers to the successful

competition of American stationary engine builders in British engineering centers and points to standardization as the secret of success. He instances a large English marine engine works in which engines of 10 to 3,000 horse power are built to gauge, and the parts stored for sale without having been put together in the shops. In this works, piece work, and a system of profit sharing, have been adopted. A standard gauge system would reduce the cost of engine erection by one-half, the Author believes. He computes that with present methods labor cost is 25 per cent greater on the hull and 50 per cent greater on the machinery of "an average ocean going freight and passenger steamer" in the American yard. As to cost of material, the tremendous fluctuations in the price of steel here is the most serious question met with "in trying to predict anything in regard to the future of shipbuilding in this country." In his opinion the tariff on steel plates and shapes makes it possible for the British builder to work Pittsburg steel into his ships at a less cost than British steel, and at a less cost than is charged the American builder for the same material in Pittsburg. In a yard on the east coast of Scotland, the Author saw steel being worked into a vessel that had been delivered in the yard from Pittsburg at less than £7 2s. 6d. per long ton. As the duty on steel is not a protective measure, and cannot produce revenue, the Author holds "it should not be maintained to render wild fluctuations in price possible." Engine forgings cost more here than in England—about 30 to 50 per cent—and in high grade forgings, such as for the U. S. Navy, there is no comparison. British forges charge £4 a ton extra for each 1 per cent of nickel in steel, but nickel steel is little used there in merchant work. In the item of wood, the British builder has an advantage of about 10 per cent in cost of material. In conclusion, the Author says, we are not yet in a position to compete with British or German builders, the difference being not less than 15 per cent in the finished ship against us. With continued experience and the labor question solved this difference may ultimately disappear. In the meantime legislation will be necessary to enable the American builder to compete successfully with his foreign rival.

As the Author, George W. Dickie, of the Union Iron Works, San Francisco, was not present, the paper was read by Walter M. McFarland.

DISCUSSION.

Naval Constructor W. J. Baxter said that, with regard to the skill of workmen, it had been his good fortune to spend two years in Scotch shipyards, and subsequently a number of years in American yards, on both the Atlantic and Pacific coasts, and from personal experience he could testify that the output per hour of the American mechanic exceeded that of the workmen of any other nation.

Naval Constructor John G. Tawressey, in discussing Mr. Gillmor's paper, said that he had the opportunity some years ago to examine a number of British shipyards, though he was not familiar with recent progress there. He was surprised, however to learn that the air plant was not making its way more rapidly in the British yards, particularly in view of the experience that had been had in this country, where it had been adapted to almost all kinds of work, both steel and wood work. At present he was using it, not only for boring and drilling, but even for driving nails, buffing work, and for sand papering boats when they were otherwise finished. At the last meeting he had made inquiries as to the experience of others with air in a cold climate, as to what should be done to keep the pipes from freezing. He had been told by some to heat the air, by others to cool the air, and by still others to do nothing at all. Since then he had tried all three methods and had found all three about equally successful. There was perhaps an explanation for this in his own experience, as at the Navy Yard in New Hampshire when the temperature becomes very low the air also becomes very dry. The relative humidity is of very small amount, and consequently the air taken into the compressor is dry and there is little or no trouble from moisture. The working temperature there was often, during working hours, only three or four degrees below zero, and sometimes in winter even lower than that. Ground in the yard is rocky and the air pipes are sometimes run on top in a wooden box, and in other places only a few inches under the surface. No trouble was experienced, provided that the water was blown out about twice a day. They had also tried the experiment of passing the air through a cooling coil, and also through a receiver with steam pipes inside. The only real trouble that was experienced was with the last—it froze up last winter. The question of an electric drive was of especial importance in navy yard work, as they had a great many machines suitable for various kinds of work, and these had to be ready so as to be able to do work quickly in any emergency. The conditions were that normally, in the yard, the machines were standing idle and, consequently, if an independent drive for each separate machine or group of machines was not adopted a great deal of horse power would be thrown away in turning over the shafting and the belts in the entire shops. It was a question of probably greater importance in the Navy Yard than in the ordinary manufacturing establishment, where the normal condition was that each machine would be doing its work. In the yard in order to have proper capacity for emergency work, it was necessary to have a great many more machines than the ordinary daily routine required. A shop without a belt would be an ideal one, but he had made no attempt to approach that condition, and, consequently, did not know what economy would result from such an arrangement. He thought that probably it would be overstepping the mark, but they had found that there was great economy in driving the larger machines independently, and grouping the smaller ones, so that the shafting connected with any particular group could be left idle, except when it was necessary to operate some one or all of the machines. Several years ago, when going over British yards, he had been impressed with the work of the beveling machines, and he did not know whether they had been put in operation in American yards. He hardly felt justified in putting one in for repair work, but he would very much like to have the opportunity to test

this machine if he had any new work to do. As to joggling machines, he understood that in addition to their use for plate work they were being adopted to some extent in the lake yards for angle bar work. With regard to oil furnaces for both plates and bars, he had found that in the intermittent condition of work in the Navy Yard such furnaces were very successful.

Naval Constructor W. L. Capps regretted the absence of Mr. Dickie; were he present it would undoubtedly stir up discussion on his paper. He had often wondered if anybody really knew what cost was. Many persons had given data on the subject, but unfortunately the same subject approached by different people produced entirely different results. "The actual cost of labor and material as between this country and Great Britain and Europe presents great diversities. I think, as Mr. Baxter said, that unquestionably American workmen are giving a greater output per hour than the workmen of any other country. That may be due to the greater nervous energy that Americans are supposed to have."

Mr. McFarland: "Strenuous life."

Naval Constructor Capps: "Strenuous life—I accept the amendment. The cost of material apparently cannot be controlled at all except by large interests. They control it to suit themselves. The ship builder has to take what he can get. As to illustrating the difficulty of arriving at actual cost of work, I know one case that came under my observation in which a contract was drawn so that certain work should be paid for at the rate which would be expressed by the cost of the work plus 10 per cent for profit. It seemed a very nice arrangement, the people were exceedingly reputable people, and everything was lovely, until the time came to settle for the work, when it took about six weeks to get anywhere near the cost of the work. The contractor made various statements, each one being the real cost of the work. But through pressure and a certain amount of argument, etc., these statements of actual cost diminished progressively. The upshot of the matter was a reduction of about one-half in the final settlement, and yet the same certified statement came with each one. So I concluded after that the question of dead cost, as viewed by the contractor and the other interested party, was a matter open to much discussion, and the people who knew most about it are not going to give us the facts."

W. D. Forbes said that no matter whether we adopted the electric drive, pneumatic tools, or other equipment, the other shipbuilding nations of the world would be equally able to use the same apparatus. Sometime ago he had the pleasure of showing around his works a well known foreign torpedo boat builder, who, after examining the equipment and the work and discussing prices, said: "If I get American machinery and take it over to my shop I do a little better, but I never do as well as you here; so I have made up my mind that the only thing to do is to take Americans there with American machinery." Continuing, the speaker said he believed this to be a fact. Many years ago, as a youth, he had worked on the Continent and in Scotch and English establishments, and it was his experience that the whole system abroad was so radically different to ours that no proper comparison could be made.

"I do not take any stock in the nervous temperament. What affects a man's work is the money he gets, and the more money he gets the more work he will do. If cheap labor was going to produce the manufactured articles of the world, China would become a very serious competitor. No nation need be a scarecrow to America until the wages paid to a man in the same position, doing the same work, approach ours. I have just turned my shop from the ten-hour system to the nine-hour system. I have made up my mind that the whole thing turns on a man's pay. The more you pay him the more you can get out of him, and the better work you can get out of him. I do not believe it is possible to have the United States stay behind in the cost of anything any length of time. I have not been in Europe for five or six years, but I saw methods when I was there in one shop that have been in existence and have not changed for years and years. I am doing work in my little shop at a hundred per cent less than they are doing it in London, with all the cheap labor, and material practically about the same. I do not believe that we have to look so much to what the machine tools will produce in cheapening our work. We are getting pretty near the limit. Of course, the introduction of this tool steel, which I see the Bethlehem people have brought forward, may help us in a great way. Jewel points to tools, I think, will be used for fine work, and used to great advantage. But all these things foreigners can get as well as we. I do look for a very great advance in cheapening products, especially for large engines, in the foundry. There is a place where we are not doing the work we ought to. A little while ago I was asked to give an estimate on some very large cylinder heads. I don't know where the engines were to go, but their estimate was about $400 on those cylinder heads. At an additional cost of about $60 per pattern the work was brought down to $40. That can be done in a great many cases. We are machining work too highly. We are taking too much care to get a bright finish that some chap with a wrench spoils the first time he gets a chance. I believe we must look to the foundries. There is one in the central part of New York that produces work the parts of which will drop together. You all know this little cyclometer. That is simply sent to the finisher in barrels, and the parts are simply taken out of the barrels and put together. The work is as accurate as any you can get from any ordinary milling machine. I had a pair of bevelled gears with a hole about 3-8 in. and a pin hole about 1-16 in. passing through the larger hole, and when I put them on a ground arbor they ran perfectly true. We can get the shipwork that is now being done in Europe, but we cannot get it unless we pay greater attention to the third subject mentioned here, and that is cost. I find that if a man is getting two dollars and a half from me and he knows that if his work equals that of a three-dollar man he is to get three dollars, and that I keep an accurate account of the work he does. That man is always pushing himself

to get the three dollar pay, and I get an immense amount of work done in that way, and in adopting that system I believe I have struck the keynote of getting the most out of the workmen that come under my charge."

E. Platt Stratton said that when abroad last summer he had business with three of the most prominent shipbuilders in the United Kingdom, one in Ireland, and two on the Clyde, and he had been very much surprised to find that each one of them had an expensive equipment of American machine tools. In one case he found that in a foundry a number of American molding machines were in operation. This, he believed, showed that the British yards were not very far behind in the matter of machinery.

Naval Constructor Francis T. Bowles inquired of Mr. Stratton as to why he differed from Mr. Dickie in the suggestion that "an American register of shipping that would be accepted by the shipowner and by underwriters the world over would be a great help to the American shipbuilder." He would like to know why that would not be a good thing, and why it was not practicable; and, also, what part the American shipbuilders of to-day were prepared to take in the regulation of the classification societies.

Mr. Stratton replied that the classification society acted generally in a financial capacity as an intermediary between the shipbuilder, the shipowner, and the underwriter, and classification was controlled by the financial interests rather than by the interests of the shipbuilder or the ship designer.

Mr. Bowles: "But the classification society is essentially a technical organization. Now, the financial interests have got to hire somebody to do the work, and it seems to me that the shipbuilder, while he should not control the classification society, should supply the technical knowledge and he should be fairly represented. He should not actually control, but he should have such a representation that he could not be stifled."

Mr. Stratton: "The shipbuilder has always got an appeal. He has always got an opportunity to be heard in every instance. The shipbuilder is never sought to be throttled in any way, manner or shape, and the most recent rules, the rules which the American Bureau of Shipping adopted last year, were only adopted after they had been referred to every shipbuilder in this country and many in Europe, and their approval, without a single exception, was received. That is, where they responded to the circular they invariably commended those rules as satisfactory."

Walter M. McFarland said he would like to hear discussion upon the point made by Mr. Dickie that it cost 50 per cent more wages for about 50 per cent of the work on this side. He would like to hear from those who had figures, and who had familiarity with this matter.

Theodore Lucas called attention to the statement of Mr. Dickie that a considerable per cent of the cost of the hull and engines was included in that part of the work which was done by day's work, and this he understood also covered carpenter work, joiner work, painting, and the finer fitting. He believed that carpenter work, joiner work, and such matters, could be laid out in piece work, if the work was laid out by the foreman in such a way that the workman could intelligently bid on it. It was a question of distributing work in such a way that it could be brought down to units, so that the office could readily estimate on it first, and the workman also. Carpenter work, which included planking, ceiling in the holds, and other plain work ought to be laid out so that the price per square foot could be determined beforehand. With much of the joiner work and painting the same methods could be adopted. Certain manufacturers who used the pneumatic apparatus for painting large surfaces let out the work by the square foot. In England, he understood, a certain amount of work was given to a certain gang of men after they had made a bid on it, and all of this work was then entrusted to them. In the ships, such work as the shearing of plates or punching of plates could be readily handled by gangs in this way. Similar methods might be adopted in the machine shop, so that planing, for instance, could be let out at so much per square inch, or the work could be figured by the amount of material in weight that was removed from certain pieces of the engines. He believed that it would be found that workmen would be able to turn out more work of a satisfactory character if they could go right ahead on a large amount of work of the same character.

John C. Kafer said he had no doubt that this system would be possible if the builder had a large number of vessels of exactly the same kind to work on. As matters were now no two ships were identically the same, and he did not think it would be possible to lay out work in that way. The shipbuilder to-day makes his estimates on the amount of work to be done, from his knowledge of what such work had cost him previously, and so it would not be possible to make any great reduction unless a large amount of work of the same kind was to be handled. The question resolved itself largely into one of wages, for if work in duplicate could be done here it could also be carried out on the same lines abroad. In England the difficulty met with was generally on account of the labor organizations, which restricted the output. In Germany, however, the conditions were rather different, as he found on inspection last summer. There the American method of having one man attend to more than one machine had been adopted to an extent.

Mr. Tchernigofsky, I. R. N., said with reference to piece work that he would like to hear how the quality of work was affected by giving it out in this way. In his own experience in the Russian Navy Yard he found that the quality of piece work was not as good as that produced by day's work. They had appointed special inspectors to examine piece work, but it was frequently difficult to say whether the work should be accepted or condemned. Very often the work was not satisfactory.

John C. Kafer said that in certain parts of ship work it was very easy to have piece work properly done where circumstances were such where the workman could not do any serious amount of damage. If, however, plates were let out to be punched by

piece work and the workman happened to punch the plate in the wrong place, he would not be willing to pay for the loss of material, but would prefer the owner to take this loss.

W. D. FORBES said he had tried piece work, and while it worked very well on certain jobs, such as tapping a large number of holes of the same size, where there was little possibility of error, he found that to maintain the quality of work produced the game was not worth the candle. In certain lines of work where parts of the same type of machine had to be duplicated, piece work had been adopted, such as in the manufacture of small pumps; but when it came to extremely accurate work he believed that it became necessary to abandon piece work. It was better to employ a thoroughly competent man to look after the workmen and see that they were doing a fair amount of work, a man corresponding to the "prime cost clerk" of the old world. This individual was cordially hated by by everybody except the stockholders, because he would get after the men in such a case, for example, as when they would get out a shaft in eight hours one day and eighteen the next because there was not much work lying around the shop. He believed that if attention was given to the time cards, and the ambition of the workmen appreciated and properly remunerated, the piece work system would go out of existence.

H. F. DONALDSON said he believed the national temperament had something to do with the output, for high wages had not been a solution of this matter abroad. In a conversation with one of the leading English shipbuilders last summer, he had been told that they had the greatest trouble with the men who earned the most money. Some of the men who belonged to the riveting gangs made very large wages and would work only three or four days in the week, and during those days they would make the equivalent of an ordinary week's work. Then they would lay off for the rest of the week and not appear again until the beginning of the following week, and they kept this up right along, so that the yard actually got less work from those men than it would get from men working regularly at the ordinary rate of wages paid to other workmen.

CHARLES H. CRAMP said that they had had an experience with a lot of their men some time ago whom they found were working Saturdays and Sundays getting double time. These men would not work on Mondays and Tuesdays. They could afford to lay off for a couple of days.

WATLER M. MCFARLAND: "That shows that the men were possessed of American shrewdness. The fellows on the other side are too dull to do that."

W. I. BABCOCK expressed his appreciation of Mr. Dickie's paper, but said he did not agree with the Author's conclusions. He had some timidity, however, in speaking on the subject as he would have preferred to have heard from members who had experience in coast yards. His own opinion regarding costs based on actual facts were derived from experiences on the Great Lakes, and in the building of a class of ships which differed in many respects from those referred to in the paper, and to which its conclusions were meant to apply.

"As to skill in design little need be said. He would be a bold man who, in this room and before this distinguished gathering of the fraternity, would admit for a moment that America was lacking in that respect. From the days when the *Constitution* outsailed the whole British fleet down through the time when the American clipper ship was the acknowledged queen on the seas, to the present day, when the America's cup is still with us and the *Variag* holds the steaming record, the American designer has been at the head of the list, and no one doubts that he will remain there, no matter what new responsibilities may arise.

"Mr. Dickie's opinion that at the present time the British builder has an advantage of about ten per cent over us in the cost of material, I shall not attempt to dispute. He knows a great deal more about it than I do. In the long run, however, it seems absurd to suppose that this advantage can continue, and it seems to me not only can it be neglected now, but that we can safely count on the difference being the other way in the very near future. As a matter of fact, if we are able to ship steel to England there is hardly any reason to suppose that through a long term of years the shipbuilders in this country will have to pay more for the same steel when they have not got the ocean freight against them. I do not think the question of material need to worry us at all in that respect.

"There remains only the cost of the labor, and that is by far the most important of all. I must admit that I do not quite follow Mr. Dickie's figures here. He says that our total labor cost on a ship is twenty-five per cent more than the British cost, and also that the labor cost of the steel work of construction alone is about the same in both countries. With this latter statement I agree, for I arrive at the same conclusion from such information as I was able to obtain when over there three years ago. On the Lakes the labor on the steel work alone of a ship is about thirty-two per cent of the total cost of that ship, and all other labor, painting, carpenter and joiner work and outfit (excluding propelling machinery), ranges from seven per cent in a bulk freight steamer to twelve per cent in a package freight steamer, the latter meaning a boat with main deck, gangways, and hoisting machinery, and the former an ore, coal, or grain carrier. Now, if the labor cost on the steel work is the same in both countries it is impossible that an addition of some fifty per cent to the cost of the other labor—which in any ship would be considerably less than that on the steel work, though perhaps not as much so as on the Lakes—would add twenty-five per cent to the total labor. That is, the labor on the hull is the principal labor in a ship, and Mr. Dickie says himself that he thinks we can do that just as cheaply as they can on the other side—a steel hull. As I say, on the Lakes the other labor is almost from seven to twelve per cent of the total cost of the ship. Whatever you add to that is a very small proportion to add to the total labor. Mr. Dickie seems to think that the explanation of the equal costs in steel work lies in the piece work system. But his own statement is that even on work supposed to be done by piece there is more day work than piece work. How, then, does he account for equal costs, even supposing piece rates are the same, when our day wages are so much greater, fifty per cent he gives it,

though I think it is nearly seventy-five per cent? It seems to me the true explanation is that our men do much more work in a day, that they are very much steadier and lose a great deal less time, that they are not throttled and held down by the restrictions of labor unions, that the working day is better divided up, two periods instead of three, that our yards are better arranged and have better machinery and our management is better. Now, if we can overcome the handicap in wages in steel work, why can we not do the same in everything else? We can, and all we want is work enough to keep our yards occupied all the time, and a little more experience to prove it. It seems to me that the true explanation of the fast that we cannot compare with them in cost on steel work is, as Mr. Baxter says, that our men do a great deal more in a day. They are very much steadier. They lose a great deal less time. The English shipping papers have stated, a good many times in the last year or two that the average loss of time of the men in the shipyards in the north of England or Scotland is almost thirty per cent. That is, a man will lose nearly two days out of each week, and that unsteadiness, it is unnecessary to say here, is a very serious thing. It adds very greatly to the cost of the work. If you cannot depend on the men coming in and doing the work every day of the week it makes the cost of the work run up. Besides that, our men are not so much under the control of the labor unions by a great deal. Over there they are fairly throttled. No matter what an individual wants to do, he cannot do it. He is kept down by the labor unions, and the whole policy of the labor union is that if there is a certain total amount of work in a district, if they can make every man do less work individually per day, there will be more men employed, because in that case there will be more work to go around. Well, that works in that way in some respects, but the effect of it, of course, is to increase the cost of the work. Besides that, our working day is very much better divided up than theirs. The almost universal custom over there is to have two intermissions during the day. That is, the men go to work in the morning and then stop about nine o'clock for breakfast. They stop again at noon for lunch or dinner, and that makes three periods in the day. Now, of course, there is a great deal of time lost just before the shutting down of the shop or the yard, and there is time lost again when the men go to work. It will vary, it is pretty hard to put a time on it, but it probably averages fifteen minutes for each man for every intermission. That is, to get into the swing of his work again, and get to working steadily. Of course, in this country the work is done in two shifts only. I think it is very fair to say that our yards are better arranged, as a rule, than the English yards, and also that they are better managed. In Mr. Gillmore's paper there is a hint that one reason for that where he says that there is no inducement toward putting in improved appliances for handling material, because the men will not reduce the piece work rate. Of course, there is no use of a firm putting up an expensive machine, for instance, if they cannot do the work any cheaper when they have got it. In this country we have no restrictions of that kind.

"I think that all we need is work enough to keep our men steadily engaged, not having a feast and a famine, as has been the case for a great many years in the business, as we all know, and we can prove it that we can do it as cheap as it can be done abroad. In what I have said I have not included the engines. I am not at all familiar with the cost of English machinery, and I am not competent to express an opinion on it, but at the same time I do know this: There is a very large manufacturer of mining machinery in this country, probably the largest manufacturer of that class of machinery in the world. The firm have one shop in Chicago, and they have one shop in London. They build exactly the same machinery in each place from the same designs. The wages in Chicago are a great deal more than the wages in England—in the two shops. Doubtless the same difference that there is in the wages for other classes of labor, that is, in ship yard labor—it runs from fifty to seventy-five per cent more in Chicago. But they can build the same machinery in Chicago cheaper than they can turn it out in the English shop."

Alexander J. Maclean, referring to the statement in Mr. Dickie's paper that the average cost of the steel work of construction in the British yards was from £3 17s. to £4 per ton of material worked, said he took this to mean only the piece work prices. He had been looking over some figures on the cost of English ships which he had, and found that for the merchant steamer or "tramp" the average price in the north of England for a vessel up to three hundred and twenty feet in length was £3.17 per long ton of actual weight of steel worked in the vessel. The cost of labor for the other trades—and about twenty different trades came into play in finishing those ships—was very much higher than the cost of labor on the material in the hull alone. This, of course, would apply to a greater extent in vessels fitted for passenger service. Taking the figures on six vessels of the latter class, the labor and material should be an average of £5.76 per ton, and taking the entire cost of labor, the figures were £9.37 per ton. On the steel work in the hull it cost £4.62 per ton, and with all fittings included £4.46 per ton, while vessels, of course, especially of new types were very much higher. The cost of labor in the case of some cruisers of new type on the steel work alone amounted to £17 to £25 per ton. He did not hold with Mr. Dickie as to the statement about the amount of work done by draftsmen. Speaking from personal experience in British yards, he could say it cost very much less there to run a drawing room than it would here. In some British yards the chief draftsman was allowed so much to run his office force, including the cost of material used, and this sum was usually considerably less than it would be over here. As to costs of management, he could not speak authoritatively, but he believed that the cost of the managing force of an English ship yard was very much less than that of a similar ship yard in America.

Mr. Bailey spoke about yards in which both merchant and government work was turned out. In a ship yard that handled government work the men formed habits of extreme carefulness, and when these men were changed from government to merchant work they retained a large amount of this carefulness

which the government inspectors had enforced. For ships built for the merchant service and the general run of tramp steamers, such carefulness was not required, and it caused the work for the merchant ships to be very expensively carried out. He believed that in England the yards that built merchant work turned out a large amount of it, and the men were kept almost entirely upon this work, so that they knew just exactly what finish or accuracy was required.

Naval Constructor Joseph H. Linnard: "There is just one point that has struck me in this discussion. Those of the speakers that admit the fact that to-day we cannot compete with the British in building ships of any class seem to be undecided as to the reason, and point to our ability to compete in other lines of manufacturing, as being necessarily a reason why we should be able to compete in shipbuilding. I think, if we reflect on the lines of manufacture in which we have within recent years been successful in competition with foreigners, we will see that they have been such lines as we have in our own practice standardized. The manufacturers have standardized the types of land engines which have been spoken of in this connection. They have standardized electrical machinery. Their whole production tends to a standardized arrangement of their outfit, which becomes regular in process of manufacture, and can be put forth with a complete arrangement of their shops towards a definite and fixed end from the beginning, The question that arises in my mind is whether we will ever be able to build ships on that basis, whether we will ever be able to *manufacture* ships instead of *building* them, and that is a question that I have not heard any of those members who are engaged in commercial pursuits touch upon. I would like to hear something from that point of view."

The Chairman: "I would like to say that that is a very original idea of yours. The difference between manufacturing and building ships has always appealed to me."

E. Platt Stratton said that in English yards he had noticed that, frequently, in the case of tramps, three or four vessels would be laid down at the same time, so that the molds and the machinery outfit would be alike for all the ships. Here it was the rule to build a single ship, and where there was government work in hand the men shifted about a good deal from one style of work to another. He understood that English builders figured that where three or four vessels of the kind were built at one time the cost would be about 15 per cent less.

Col. Edwin A. Stevens said that it seemed to him the question was not so much as to the present cost of ships built here, but as to the probability of the American shipbuilders being able to compete with the English shipbuilders in the future. It seemed to him that the question was one of demand and supply. He had great faith in the American mechanic and greater faith in the American engineer, and he had invariably found that where the latter had a fair show he was pretty apt to come out near the head. He did not think it would be possible to standardize ships, but the work could be specialized. The American ship yard to-day, in order to make money, had to take everything that came along; tug boats and torpedo boats, and, perhaps, battleships were built in the same yard at the same time, and even repair work might be going on. He believed that better results would be had by carrying on such work in separate establishments, or at any rate, by creating separate departments in the same yard, and not having the work mixed together. The way to attain this end would be to create such a demand for the product as would justify shipbuilders in specializing. It was in this way, and this way only, that American bridge builders, tool builders and makers of various other classes of machinery had been able to compete successfully, not only with England, but with every other foreign nation.

W. I. Babcock, referring to the figures which Mr. Maclean had given, said he had figured out the costs per pound, which was the way they were figured on the Lakes, and he found that this gave a result of a little over eight-tenths of a cent per pound for the English tramp steamer. He could say that on the Lakes this figure had been beaten, but he believed that such figures were not valuable as a basis of comparison unless it were known how the costs were made up—what was included and what left out. The same would apply to the figures given by Mr. Dickie, as there was nothing to indicate how the cost was made up.

Lewis Nixon: "Many people say, in view of the fact that we are building men-of-war in this country at prices which compare very favorably with prices received abroad, that we ought to do the same thing in merchant ships. The conditions are very different. Men-of-war are appropriated for, and while sometimes the appropriation is not that which would build it, at the same time there is an appropriation, and the ship yards can be organized for the purpose of building them. When we are in such a position that we can build a million tons of merchant ships in a year, we will then have the demand which will enable us to so arrange the building of merchant ships that we can build with reasonable economy, and I have no doubt in the world that by that time we shall be able not only to meet the price of the foreigner, but to come under it. But in order to bring about that condition it is absolutely necessary that there should be a demand for ships which we have not now, and until we can get that it is absurd to talk of building merchant ships as cheaply as they can build them abroad. In one of the largest ship yards in this country there are five slips, each capable of building a *Campania;* and recently on one was a tug, on another a battleship, on another a ferry boat, on another a yacht, and on a another a revenue cutter. It is absolutely impossible to practice economies under such circumstances and build the ships so that they would compare favorably in cost with ships built abroad. However, there is some promise in the future, and if we can get down the cost of the raw material, there is not any question in the world that with the demand that seems to be coming we shall be able to meet and go under the price of the foreigner. Until we have that demand and we cannot get it without appropriate legislation, it is absolutely impossible to build mer-

chant ships here as cheaply as they can be built abroad." (Applause.)

The Chairman now announced a change in the order of the programme, and called upon Mr. Taft to read his paper.

A COMPARISON OF THE CONTRACT PRICES OF OUR NAVAL VESSELS.

BY HARRISON S. TAFT.

This paper is primarily a collection of charts and tables which are intended to show the "contract cost," "cost per ton" and "cost per ton-knot" of the vessels of the U. S. Navy, both numerically and graphically. They must be consulted with discrimination, for a variety of reasons, as the Author points out. The contract price of a vessel, especially a naval vessel, does not represent the actual cost of construction—completion. Usually in naval work the contractor builds the hull and machinery, in which, during the process of building, extensive changes are made and paid for as extras, and the guns, armor, and equipment are furnished by the government, the installation expense being taken up by the contractor. Some of the naval vessels have been completely furnished and made ready for sea by the contractor, while in the case of others, the joiner and outfitting work have been done at a U. S. Navy Yard. Again, in many instances speed premiums have to be considered. In the tables the classification of vessels follows that adopted by the Navy Department, viz., battleships, monitors, armored cruisers, cruisers, gunboats, destroyers and torpedo boats. The four ships built at the Navy Yards and the four double turretted monitors have been omitted. "The cost of a hull proper does not increase directly as its tonnage, nor does the cost of an engine vary directly as its horse power. Since the horse power varies approximately as the cube of the speed, the cost of an engine will vary as some power of the speed between its square and its cube, which, of course, will make the total cost of a vessel vary more than directly as its speed." It might have been admissable to have employed some power of the speed in obtaining the figures entered under "cost per ton, knot," says the Author, but all the variable quantities entering into the solution of the problem made this refinement impracticable; and, besides, the results are relative, not absolute. As an illustration of the effect of this variation he calls attention to the "cost per ton" of the three last battleships contracted for, which is larger than for the three preceding battleships, while the "cost per ton-knot" is less. In the charts, accompanying the paper, the curves are plotted in sets, with years and months as abscissa and dollars and cents as ordinates. The several sets show the "cost per ton" and "cost per ton-knot" for individual ships, for different ships built by the same firm, and for ships of the same class built by different firms. They also show averages, extending over stated periods of time, comparative costs of different classes of vessels, and also of different firms of contractors. An analysis of the curves shows that there has been a gradual fall in the contract price of battleships and a "nearing together" of the prices of different firms. The abnormally low figures for the *Kearsarge* and the *Kentucky* are noted; and the Author points out that in the case of the last three battleships contracted for the points of the Union Iron Works are below those of the two other contractors, even with the heavy freight rates working against the Pacific coast yard. Comparing the *Denver* class of cruisers with the *Columbia* and *Minneapolis*, it is shown that though the former are each 4,175 tons less in displacement and 4 1-2 knots less in speed, the price per ton-knot is $2.39 higher than for the older ships. The high price for steel in the fall of 1899 is held to account for this, in large part. In the gunboat class there is less uniformity of prices than in the case of the cruisers, which latter show a greater uniformity than any other class. The widest range of prices is found in the torpedo boat classes. For the "cost per ton" there is a difference of $800 per ton between the highest (*Dahlgren* and *T. A. M. Craven*) and the lowest (*Davis* and *Fox*) contracts. In this class of vessels it is noticeable that in the plotted curves the points for the destroyers are much below those for torpedo boats. In summing up, the Author says that since 1888 there has been a gradual fall in prices for all classes except protected cruisers, which class has had a steady and continual rise since the beginning of the new navy. Battleships are shown to cost less per ton-knot than any other class, but this is leaving out the item of armor and, of course, armament. The three latest battleships, *Maine*, *Wisconsin* and *Ohio*, shown without armor, $234 as the "cost per ton" and $133 as the "cost per ton-knot," and with armor $390 and $217 respectively. In conclusion, the Author regrets that the latest authorized cruisers and battleships have not been contracted for in time to include them in his interesting investigation.

DISCUSSION.

Lewis Nixon said the paper contained food for reflection, but anyone who imagined that the shipbuilding fraternity of the country would get valuable data from it, from which to make estimates, was wrong in his judgment. In the first place contract prices did not always represent contract cost or actual cost, and the figures which had been presented and which were made on gross displacement, told nothing when it came to the question of the boat upon which the builder lost money. Another point, he believed an optimistic view, was where the author spoke of launching torpedo boats with steam up, passing them through their trials in a few hours, and then turning them over to the Government.

"I have been in just such a problem as that, and to get even with the trial trip is the most serious thing I am going to have. Any one who imagines that he is going to launch with steam up, go through the trial trip in a few hours and be accepted by the government, has more faith in his powers than is justified by my experience. The question of cost is one which should be discussed here as far as you can discuss it. The best stock in trade of a ship yard is its cost book. Probably there is nothing so valuable that they have. They can throw away their plans and specifications and patterns, and everything else, and would not miss them at all in the same measure as they would their cost book, and when a man thinks that he can estimate the cost of a boat with absolutely no experience, such

as would come from a thoroughly well prepared book of costs extending over a number of years, he is absolutely mistaken and simply can not make up an estimate of costs. But this paper being addressed most directly to the naval ships, I think that we ought here to look at just that problem that we have to meet in the naval ships. I remember one of the most hopeful signs that the country had in building a navy was when the present Chief Constructor, about 1885, visited the shipyards of Euope, and with his sense of perspective not interfered with in any way came back and published a report, and one of the most striking things in that report was his commentary upon the needless and growing complication of men-of-war, and we are now putting things in men-of-war which I do not believe are needed. Now, in old times, and in fact up to within a few years ago, we were perfectly satisfied to work the valves of steering engines by flexible wire ropes. You could destroy your decks, turn over your beams, do almost anything, but as long as that rope was not parted you could work the steering valves. But along comes a man who wants to suggest something better. He gets up some beautiful scheme of electricity or water, and simply because it will work at the dock, or sometimes under trial, it is hailed as a great discovery and promptly put in every ship that we have to build. I have in mind two boats, a battleship and a cruiser, where an electrical arrangement for working the valves was put on. One of them in column of vessels at sea, during a trial, got its helm jammed over and was thrown out of the column. Had she been thrown in towards the vessels on the other side, probably the results would have been most disastrous. I am not quite sure, but I think those two boats when they reached the Navy Yard at Brooklyn had this electrical steering gear promptly taken out, and that change received the endorsement and approval of the admiral commanding. We put in the next boats a scheme to work the valves by water, and then in order to make the water gear work perfectly we added about twelve pages of specifications of electric gear to describe how the water gear worked. On one trial of one of those ships a man went down to overhaul the valves and opened something in the line of the water and the thing stuck, and then this contrivance was abandoned and we have come back to the old wire rope. Those are only points which show that some things can be given too much weight. Simply because something is suggested that will work under some circumstances, it does not mean that it ought to go into a ship. It seems to me that those remarks of the Chief Constructor should be accepted as an axiom. It is the duty not only of this Society and of the construction corps—of course, I do not want to tell them their duty—but as one who sometimes attempts to build their ships, I want to say that I think all shipbuilders are interested in doing away with complications, because complicated things generally fail to work at the time we most need them.

"As regards the limit of cost of ships, I think we have an object lesson in that, which ought to be brought very strongly before the people. We have a number of cruisers appropriated for at a certain limit of cost. I believe the ships were intended to be about 8,000 tons, which means anything you choose to put in, but that anything should mean within the limits of a reasonable cost, and leave a profit to the builder. When people come to look at this problem in all its lights they say: Has the Department men trained to design ships and men who understand something about the cost of them? For men to design ships which they deliberately know cannot be built within the limit of the appropriation, and to attempt to get ships contracted for which every one knows cannot be built for the money appropriated is almost a crime, because people having faith in the men who design these ships think they are getting out ships which are not beyond the limits of the appropriation. The present protected cruisers, instead of being protected cruisers, are really designed as armored cruisers. Undoubtedly the question of high explosives must be taken into account, but a certain amount of money was appropriated to build those ships, and no one has a right to get up ships which cannot be built for the money which is appropriated. (Applause.)

"I might add to that, if you will allow me, people tell me that is all right—these ships will go to the navy yard. It was the intention of the country to have ships built for $2,100,000 or $2,200,000. Does it follow that because we find in competition many people who must have work to keep their place going, who thoroughly understand the methods of running their ship yards—does it follow that the Government is any better off because under false pretences they can put that boat in a navy yard and pretend to get it anywhere near the competing limit at which the shipbuilding establishments of the country refused?"

Naval Constructor Francis T. Bowles: "I am sorry that Mr. Nixon felt called upon to say anything unkind about the paper. The paper serves to bring up a very interesting matter, and it traces merely what you might call the technical work up to date, as it appears to Congress. I entirely sympathize with Mr. Nixon when he advocates simplifying the vessels of the United States Navy and thereby decreasing their cost and increasing their efficiency. There is no doubt whatever that we are all ready, a trifle too ready, to take up so-called improvements, with the idea of increasing the efficiency of the vessels. There is no doubt also that every time anything is required for a battleship in the way of a machine and a certain standard is set, and if it so happens that the contractor gives us a little better, a little more efficient machine than we have asked for, we are not satisfied to ask for the same thing a second time. But we push up the specification to the highest point that has been reached, without any regard as to whether the first specification sufficed for the purposes of this machine. Now, that of course increases the cost at every step. I have the utmost sympathy for Mr. Nixon and the interests that he represents, the shipbuilders' interests, with reference to designing ships that cannot be built for the appropriation. Now, the reason for that ought to be made clear. It seems to me that pretty much everybody now-a-days designs ships; there are a great many amateurs in the business, and until the designing of ships can be located in some responsible place and by people who are trained for the purpose, this difficulty cannot be overcome."

THE CHAIRMAN: "There is a great deal to be said on that side. I am sorry that you stopped where you did."

MR. NIXON: "I just want to add one little remark. Of course, I did not mean to reflect on the value of this paper. I think it is a very valuable paper. I only wanted to get to the question of real cost and not contract price. As a thorough analysis of the contracts made out from the time we started our navy to the present time, I think this is a paper which will attract a great deal of interest and which is most valuable. I only wanted to call attention to the discrepancies with regard to the question of cost. By that I mean real cost, not contract price."

JOHN PLATT: Mr. Bowles made the explanation that this was simply taking the official government lists of the vessels, and tabulating the contract price. I think it very unfortunate that this should have been done in the case of the torpedo boats and torpedo boat destroyers. The Navy Department for some reason or other started building torpedo boat destroyers with No. 1 of the last lot, but as a matter of fact there were quite a number of torpedo boat destroyers pure and simple building before that time. Those unfortunately are placed in the table with the torpedo boats, and that with other things makes this table practically of very little value as a comparison. To begin with, the *Vesuvius* is not and never was a torpedo boat. The *Farragut* is a torpedo boat destroyer pure and simple, and so are the *Stringham, Goldsborough, Bailey* and quite a number of others. For some reason they were not called torpedo boat destroyers by the Department, and that has led to their getting into the torpedo boat table. This being the case, of necessity the prices per ton and per ton knot will vary very much in the table. The Author refers to the Bath Iron Works boats; they, of course, were torpedo boats, but 30-knot boats. Those two boats were appropriated for at the same time as the *Farragut*, and they were appropriated for as torpedo boat destroyers, and it was intended that torpedo boat destroyers should be built, and money was appropriated for destroyers. Well, the contractors were fortunate enough to get torpedo boats at, very nearly, torpedo boat destroyer prices, and in that case the figures will be found to appear very much higher than the boats. That brings up an interesting question of comparison. If a comparison of costs is made with the amount of money appropriated by the government for any specific set of boats, it will be found that the cost bears a very close relation to the amount of money that was appropriated, except in almost every case of new people coming in and building a boat for the first time—their prices will be found to be very much lower than the prices of those that have been in before.

"I intended to refer to the remarks in the paper with regard to torpedo boats and the question of their being launched with steam up and out of the hands of the builder, but Mr. Nixon referred to that. One of the first boats was four years in the hands of the contractors, and was then taken over by the Government. There are three or four destroyers at the present time that have been running trial trips for a couple of years—some of them The contractors told the Government and the Government told the contractors that they could build torpedo boats and destroyers in a year or eighteen months. Some of them have been under construction between three and four years now, and they are not finished yet. So I do not think that the contractor who gets torpedo boats and destroyers has such an easy time."

NAVAL CONSTRUCTOR W. J. BAXTER believed the paper would be more valuable if it had contained certain standards of reference, for example: British rates of wages paid to mechanics for different jobs, and also average commercial price paid for material. He expressed himself as absolutely in accord with Mr. Nixon on the matter of simplification in all that had been said and a great deal more besides.

Fourth Technical Session.

President Clement A. Griscom took the chair at 2:30 o'clock in the afternoon and called the members to order for the final session, which furnished the sensation of the Convention. He announced that the first paper to be read would be that by Mr. Lucas.

CLASSIFICATION RULES.

BY THEODORE LUCAS.

"The rules of Classification Associations are the result of gradual and empirical growth," says the Author in his prefactory remarks, "and are often not quite in accord with out modern most advanced practice, nor do they represent and consider all the principal factors of importance for the safety and seaworthiness of ships." These factors are: (1) strength of hull, (2) freeboard, (3) initial stability, (4) stability under inclination, (5) water-tight subdivision by bulkheads. In questions of joining, fitting, riveting and caulking, the Author believes, "a fairly uniform standard of high efficiency" will be found in shipyards (commercial work) the world over. Variety of opinion is most pronounced in point of design. In considering the first factor, the Author subdivides this head into, (*a*) determination of numerals, (*b*) quality of material, (*c*) distribution of material. To secure strength of hull a combination of parts is necessary, so that the whole will be capable of resisting deforming influences, like longitudinal or transverse bending stresses in still water or waves, shearing stresses, vibrations under inertia, influences of moving masses of machinery, etc., and also to have each individual part strong enough to take care of local strains, like hydrostatic pressures, concentrated loads of machinery, coal, or cargo, etc. "Of all these stresses, the most formidable ones are the longitudinal bending stresses, and modern ship design attempts to determine as accurately as possible the strains in top and bottom fiber of the structure as a whole, to make sure they do not exceed a certain predetermined figure or factor of safety." The scantlings in the transverse framing are largely in excess of stress requirements (they provide rigidity to the longitudinal members), and in these the strains prove usually much smaller than in the longitudinal ones. As to (*a*), determination of numerals, it is quite apparent that "a certain rational uniformity should exist in the strains of different classes and sizes of ships." Classification societies have attempted to realize this uniformity of strains by

designating each individual case by numerals, produced from the dimensions of the ship. The factors that enter into the numerals are: length, breadth, depth, girth, and for these numerals the corresponding scantlings of the important members of the ship are taken from standard tables. The Author then enters into a detailed discussion of the systems adopted by the English Lloyds, British Corporation, Bureau Veritas, United States Standard, and American Shipmasters (old) and the American Shipmasters (new), giving in the appendix numerical examples of the application of these methods to vessels of certain sizes. From the results of these calculations, he believes that the use of compound numerals is not desirable for the determination of scantlings, "favoring same to an even dangerous degree, and discriminating against others that may be superior in seaworthiness, free board, and handiness of manœuvering." The analysis of these methods suggested to the Author a system by which a single dimension might express the relation between size and strain, for the different types and dimensions, and he gives an example of this system worked out theoretically for longitudinal strength, the formula representing a relation between the square of the length and a product of strain per unit and thickness of member. After having developed the idea the Author found that the British Corporation had in force a system of classification based on a single dimension. This classification, however, slightly varies the scantlings for each size, and he believes that simpler rules could be established by considering one dimension only, particularly as in American practice—sound and coastwise steamers—there are met vessels with a small depth compared with English conditions. From the shipbuilder's point of view a reduction in the number of different sizes of shapes is desirable. "The rules of the American Shipmasters' Association," says the Author, "have been changed with the advent of this year, and adopted without reserve, the system of numerals of English Lloyds. It seems very regretable that the Association should have copied, in such subservient fashion, antiquated English rules of doubtful scientific value, that may, even in England, finally be superseded by better methods, and against which an almost endless chain of protests has been made during the last thirty years by the most eminent shipbuilders and scientific men. The strength of Lloyds is largely in commercial and financial factors, aided by the tact of a body of able officials who are competent and willing to compromise on the most glaring defects of their rules. But it is a small compliment to American engineering judgment to see such a feeble copy of an antiquated foreign system offered as a help for the healthy development of an American merchant marine just at the critical moment of a new awakening of the maritime interests." As to (*b*), quality of material, the Author states the same feeling can be had against the specifications of the quality of steel. "The American Shipmasters' Association specified in 1893 20 per cent elongation for all sizes of plates, to the apparent satisfaction of shipbuilders, ship owners, and insurance men. In imitation of Lloyds Rules and Bureau Veritas, this elongation has been reduced in the 1900 rules to 16 per cent for plates under 18 pounds, while Lloyds place this 16 per cent limit under 8-20 in. and Bureau Veritas at 1-4 in. plates and under." The Author sees no reason for this cutting down of specifications, and terms the European requirements "antiquated' and sure to change. Again he says the American Shipmasters' Association exercises no direct inspection of the quality of material, requiring only the manufacturer's guarantee. "Such lax methods of inspection ought to make it easy for steel makers to sell the poorest stuff as good enough for ships." He also criticizes the absence of any chemical requirements (limits of phosphorus, and possibly of sulphur and silicon) and failure to state contraction of area. The average hull steel is of low quality, and the Author knows cases where hull steel would not stand flanging to 90 degrees over a large radius. Attention is called to the report of the American Section of the International Association for Testing Materials, as to ships, which is appended to the paper, and also to the fact that Lake shipbuilders use specifications which call for a soft steel of 24 to 25 per cent elongation, and which cover contraction of area and the phosphorous limit. As to (*c*), distribution of material, there is much room for improvement. If merchant practice would follow naval practice to some extent, and lighten the lower part of the ship a little, and increase the stringers, sheer strakes, and deck plates in thickness, a much stronger and more efficient ship would be the result. The use of inner bottom tanks might be discouraged, and deep tanks, wing tanks, or similar arrangements substituted. These would also be more desirable for stability's sake. For correcting mistakes of design in trim or stability pig iron and not water ballast should be used. As to factor (2), freeboard, the American classification rules fix freeboard as a factor of depth of hold. This is insufficient, "as the length of the ship is of considerable influence upon the possibility of waves proving dangerous to the ship." Factor (3), stability, is utterly ignored by the classification regulations. The grossest outrages in this respect may be committed by shipbuilders without any protest from either owner, surveyor or underwriter, while a slight reduction or rearrangement of scantlings is punished by a change in the insurance rates. Supervision ought to be exercised in the direction of securing sufficient breadth in relation to depth for determination of metacenter and center of gravity. The difference between these is the metacentric height—the measure of the initial stability—and this the Author places at 1.00 to 3.50 feet as desirable values for merchant ships. Factor (4), stability under inclination, is generally satisfactory—with sufficient initial stability and the type of huricane deck ship frequently employed in American practice. Factor (5), water tight subdivisions by bulkheads, is discussed at some length by the Author. "The classification rules treat this important subject very indifferently and ineffectively." He instances the steamships *Elbe*, *La Bourgogne*, the ferryboat *Chicago* and the steam yacht *Alva* as cases in which calamities would have been "reduced to accidents of small importance" had proper hull subdivisions existed. In practice ships are often passed by classification societies in which the tops of bulkheads extend only slightly above the load line. Classification regulations might, with advantage, follow

oil-tank practice and specify bulkhead stiffening that could stand for days the pressure of a filled compartment in a sea-way. Accompanying the paper are typical mid-sections designed under both Lloyds and Bureau Veritas rules.

DISCUSSION.

E. Platt Stratton, Surveyor of the American Bureau of Shipping, formerly the Shipmasters' Association, read a statement in which he characterized the paper read by Mr. Lucas as a "tissue of pretense," and charged the Author with an effort to "advertise himself" and with "wilful misstatement." He said the American Bureau had not sought to hide the fact that it had copied Lloyds Rules "with variations," having published an announcement to this effect in its "Record." As to the inspection of steel, the speaker quoted from the "Record" a rule that the tests of material prescribed by the Bureau were to be made at the place of origin, under the personal inspection of an inspector who was not connected in any way with the steel mills. He also charged that Mr. Lucas was "spokesman" for the British Corporation, and referred to the S. S. *Verona*, built under the rules of that corporation, on which the sum of $40,000 had been expended in hull repairs after her first ocean voyage. Certain banking interests had recently asked the American Bureau to examine plans for two 11,000-tons ships designed to conform to British Corporation rules, and the American Bureau had rejected these vessels as "light and unserviceable." The plans had subsequently been changed and were now awaiting approval at the Bureau.

Mr. Lucas, after receiving permission to reply first, said that he would make no answer to the personalities contained in the paper read by Mr. Stratton, but would confine himself to the subject of classification rules from the point of view of the naval architect. He was interested solely to aid in the effort to bring the American merchant marine to the highest standard possible, for the best things only were good enough for America and for American ships. The official list published by the American Bureau of Shipping did not contain the name of any inspector who was permanently stationed at steel mills in the employment of the Bureau. As to the report sent to Mr. Stratton, the speaker understood that it was sent by a firm of inspectors employed by the steel mills, and anybody could see that those men were comparatively easily influenced by the interests of the steel mills rather than by the interests of the classification society. The case cited of the steamship *Verona*, as classified by the British Corporation, had really nothing to do with the strength of ships. It was simply a case of insufficient ballasting and of sending the ship out to sea in rough weather. There have been many cases of vessels built under different classification rules being sent to sea with insufficient ballast, and many such vessels had arrived with rivets started and in a condition demanding a large amount of repair work. Within the last few weeks the speaker had found out that the British Corporation was not the only classification society that employed single dimension rules, but that a similar rule is employed by the Great Lakes Register. In this they start with the length only and subdivide according to beam and depth slightly, but the main classification is by one single dimension, that of length only. He said that he had simply submitted his standard to the Society for discussion, and would be glad if the Society would create a standard instead of that he proposed.

Charles H. Cramp said that he believed Mr. Lucas was mistaken in his reference to the classifying and arranging of structural strengths of British vessels according to Lloyds Register. He quoted the statement in Mr. Lucas' paper that the American Bureau of Shipping had adopted the system of Lloyds numerals, against which system protests had been made by eminent British shipbuilders. The speaker said that he knew that the rules which had been adopted by the British Lloyds had been established by yearly meetings of the most distinguished British shipbuilders. The Lloyds association invited certain gentlemen who were not manufacturers of ships, but who were trained shipbuilders, to meet and modify the old plans and adopt new ones, with a view to classifying their ships. No matter what kind of classification rules were gotten up, there would be always some protest against them. He had experienced no trouble with either Lloyds or the American Bureau of Shipping. As a rule, his firm made a midship section and sent this, together with a general description of the vessel, to the Society, and he did not know of a case where the section or the plans for construction had been rejected or modified. If they had any trouble at all, it was with the inspection officers of the U. S. Treasury Department. The last three ships his firm had built were constructed under Lloyds regulations, and also under those of the American Bureau of Shipping. The first vessel completed was loaded with 5,000 tons of coal and was ready for sea, when the local inspector of the United States Government condemned the bulkheads. These bulkheads had been built according to Lloyds requirements and the rules of the American Bureau of Shipping, which had adopted Lloyds bulkhead requirements. The local United States inspector, however, refused to report that the vessel was constructed in accordance with the Government plans.

Secretary Francis T. Bowles said that he was satisfied that Mr. Lucas had written the paper in what he considered the best interests of the naval architect, and he believed it should be received in the same manner. He suggested the liberal application of the blue pencil to the written discussion submitted by Mr. Stratton.

E. Platt Stratton moved that "in view of the mistakes and untruthfulness of the paper under consideration, both it and the remarks bearing upon it be excluded from publication in the Proceedings of the Society."

President Clement A. Griscom inquired if the motion was seconded, but his inquiry met with no response.

Charles H. Cramp agreed with Mr. Bowles in the belief that Mr. Lucas had been sincere in his presentation of the matter, but that he had been mistaken in some particulars. The speaker did not believe that it would be possible to write a lengthy paper on the

subject without making mistakes. Referring to the suggestion of Mr. Lucas that merchant practice should follow naval practice to some extent, and lighten the power part of the ship while increasing the thickness of the members in the upper part, he said that most merchant ships are a little thicker on the bottom than naval vessels, but that was caused from so much wear and tear on that portion of the ship. This would be apparent to anyone who would go under a ship's bottom in dry dock.

E. Platt Stratton said that previous to his connection with the classification society he had regarded this organization as an obstruction to shipbuilders and shipowners, but he had hoped and believed that there was a medium ground on which this society could facilitate the work of the owners and builders, and in his work in that field he had endeavored to fulfill that requirement. He did not take the position that the classification society was an institution not to be criticised. Healthy criticism was necessary in order to make it what it should be, and he believed it would be a step in the right direction for the Society to take such action as it might see fit in this matter.

Sinclair Stuart said that as surveyor of the British Corporation he would like to call attention to the statement made by Mr. Stratton about two steamers under construction at Sparrow's Point, and he asked him what information he had about these steamers as to their construction, material, displacement, stability, etc.

E. Platt Stratton explained that plans of the steamers had been brought to his office, and the Bureau had reported to the owners that they would not classify the vessels, and subsequently plans of two other vessels were brought to the office from Sparrow's Point, and these he assumed to be plans of the same ships.

Sinclair Stuart said that they were not plans of the same vessels, and that the steamers which were under construction at Sparrow's Point, to be classified by the British Corporation, were so constructed that they would be insured at the lowest rate. He entered a protest against statements tending to disparage competitors or the ideas of the members about shipbuilding.

Naval Constructor W. L. Capps moved an amendment to Mr. Stratton's motion, that the Author of the paper and those who had taken part in the discussion be permitted to eliminate personal remarks, as such did not contribute to the information of the Society, or the dignity of the Proceedings.

Mr. Stratton accepted the amendment, which was put by the Chair, and in this form was passed unanimously by the meeting.

Joseph R. Oldham, in a communication, referred to Mr. Lucas's expressed preference for the system adopted by the British Corporation, in which the classification was based on a single dimension—length.

"As regards this it seems to me that using the length only would be too simple. As an example of this consider two vessels such as the S. S. *Germanic*—446x44x32—and the *Morse*—450x50x28. These hulls are almost of the same length, but are quite diverse in their other proportions. If length only were adopted to govern the thickness and strength of plating, the two hulls would be about alike. But, as a fact, the plating of the *Morse*, which is of steel, is thicker than the iron plating on the *Germanic*, and, I think, correctly so. Many other examples giving similar results might be added to show that the length only would not be suitable for regulating the scantlings. In the Great Lakes Register of Shipping I adopted displacement, regulated by the number of depths to length as a basis by which to fixe the scantlings, the dimensions of material being expressed in decimals. But what I consider better than all would be to attach to each augmentation of length the moment of inertia above and below the neutral plane, with a minimum thickness for each length. This would be simple enough and it would leave shipbuilders free to exercise their own judgment to a considerable degree without undue risk. As to the loading of vessels, I may say that the underwriters have often tried to regulate that, and sometimes with success. In the case of Alfred Holt's steamers, for instance, they were worked according to a load line approved by the Liverpool underwriters, but in those days the majority of owners preferred to load their vessels according to their own theories or practice, and the results were bad. It would, however, be difficult and somewhat hazardous for underwriters to define a load line, for such would not be of much use unless they possessed powers to detain, and that authority would be useless unless they kept a large staff to ascertain when vessels were overloaded; and altogether the matter has been found to be too complicated for any syndicate of underwriters to govern. The principal danger in overloading is not that of augmentation of bending moment—for the energy with which a vessel in her light condition rises and falls on the waves is sometimes greater than when she is loaded—as the diminution of bouyancy may reduce the stress on a floating hull in a seaway. What is most to be feared is foundering through the deck openings becoming exposed and a lessening of the range of stability, due to a reduction of the freeboard. An upper bottom appears to me to be about the most important adjunct of safety in vessels possessing stability of form, and this should be a *sine qua non* in the design of merchant ships. And if there be a double bottom, the easiest way of ballasting a ship is to fill that space with water."

President Clement A. Griscom now announced the reading of the paper on the new ships for the Navy.

RECENT DESIGNS OF BATTLESHIPS AND CRUISERS FOR THE UNITED STATES NAVY.

BY CHIEF CONSTRUCTOR PHILIP HICHBORN, U. S. N.

In opening, the Author states that the designs as they appear in the paper are incomplete, but in response to the popular and professional interest in the subject they are presented in the condition at the time of writing, together with authoritative data as to equipment, armor, armament, etc. Warship design, the Author

reiterates, is a "compromise," but he believes, nevertheless, that the designs presented, which are the result of much thought and serious consideration, will be found "superior to all previous designs of similar character produced in this or any other country." The programme, for which the designs presented in the paper have been made, includes the construction of five battleships, six armored cruisers, and three protected cruisers. The dimensions of the proposed battleships are: length on load line, 435 ft.; length over all, 441 ft., 4 in.; beam moulded, 76 ft.; draft, mean, 24 ft.; displacement, 15,000 tons. "The most noteworthy departures from previous designs are increased length, which has been necessitated by the increased speed and coal endurance demanded by many advanced strategists, inclined armor at the forward end of the redoubt, an arrangement of the casemate armor which permits the broadside battery to be snugly housed without dismounting, and the substitution of water-tube for the conventional Scotch boilers." The armament is "unquestionably the heaviest battery afloat," the arrangement being to give a powerful bow, stern, and broadside fire, and for the 12-in. and 8-in. guns the American system of mounting in turrets has been adhered to. The batteries for these ships include: Four 12-in. and eight 8-in. B. L. rifles, twelve 6-in. rapid firers, twelve 14-pdrs., twelve 3-pdrs., four 1-pdrs., and eight automatic and field guns. They will each have two submerged torpedo tubes. Armor protection will include a complete water line belt, about 8 ft. wide, ranging in thickness from 11 in. to 4 in. according to position. There is also 6-in. casemate side armor continued at the inboard ends to form a central redoubt for the 6 in. guns. Turret armor for the 12-in. guns will be 10 in. thick, and for the 8-in. guns 6 in., and the barbettes will be of the same thickness. Splinter bulkheads and gun shields will be used also. In four of the ships, four of the 8-in. guns will be mounted in the upper portions of the superimposed turrets, and the remaining four 8-in. guns will be placed in pairs in balanced turrets, on each beam. In the remaining two battleships the eight 8-in. guns will be placed in four separate balanced turrets, one on each beam near the forward end of the superstructure, and one on each beam near the after end of the superstructure. The 6-in. guns will be mounted broadside on the gun deck. The propelling machinery of the battleships will consist of twin screw, four cylinder, triple expansion engines of 19,000 collective horse power. Water tube boilers of the straight tube type, built for a working pressure of 250 pounds, will be installed. On each ship an extensive electric plant will be placed. The six armored cruisers will be very powerful vessels, of these dimensions: length, 502 ft.; beam, 69 ft. 6 in.; draft, 24 ft. 6 in.; displacement, 13,400 tons. Coal bunker capacity, 2,000 tons. As designed three of these vessels are sheathed and coppered, and three unsheathed. Estimated speed is 22 knots, and a large radius of action is possible. These vessels will be protected by an armor belt at the water line, 7 ft. 6 in. deep, running from stem to stern. Side and transverse armor will be joined so as to provide a central casement, and there will be two turrets, one forward and one aft, 6 in. thick, the barbettes being of the same thickness. There will also be splinter bulkheads, and a protective deck ranging in thickness from 4 in. to 1 1-2 in. The armament of these vessels will include: Eight 8-in. breech loading rifles, fourteen 6-in. rapid firers, eighteen 14-pdrs., twelve 3-pdrs., four 1-pdrs, all rapid fire; also four 1-pdrs., automatic, and other rifle caliber and field guns. They will each have two submerged torpedo tubes. The main engines for driving the twin screws will be of the four cylinder, triple expansion, type, of 23,000 collective horse power. The cylinders will be 38 1-2 in., 63 1-2 in., and (two) 74 in dia. by 48 in stroke. Each ship will be fitted with thirty boilers of the straight water tube type in eight separate water tight compartments. There will be seven separate electric generating units of a total rated output of 6,250 amperes at 80 volts. Designs for the protected cruisers show vessels of these dimensions: Length, 424 ft.; beam, 66 ft.; draft 23 ft. 6 in.; bunker capacity, 1,500 tons, and trial displacement 9,700 tons. These vessels will have a partial water line armor belt about 200 ft. in length, abreast the boiler and engine spaces, the belt being 7 ft. 6 in. wide and 4 in. thick. Above this for about 133 ft. of the length the sides will be protected by vertical armor, about 7 ft. in width and 4 in. in thickness, connecting at the ends with 3-in. transverse armor. The other protection will be provided for by sponsons, splinter bulkheads, gun shields, and a protective deck—according to the respective positions. The armament will include fourteen 6-in. rapid firers of 50 calibers length, eighteen 14-pdrs. R. F., twelve 3-pdrs., semi-automatic, four 1-pdrs., automatic, and eight 1-pdrs. R. F., and there will be the usual rifle caliber and landing guns. These vessels will be fitted with powerful machinery, to attain a trial speed of 22 knots. The engines driving the twin screws will be of the four cylinder triple expansion type, of 21,000 collective horse power with 250 pounds steam pressure and about 133 revolutions. Each engine will be in a separate water tight compartment, as will also be each group of four water tube boilers. There will be in all sixteen water tube boilers of the straight tube type. The electric plant will consist of five independent units of a combined capacity of 5,375 amperes at 80 volts. Names for these vessels have been decided upon as follows: Battleships, sheathed and fitted with tandem turrets, *Pennsylvania*, *New Jersey* and *Georgia*; Battleships, not sheathed and with main battery in independent turrets, *Virginia* and *Rhode Island*; Armored cruisers, sheathed, *West Virginia*, *Nebraska* and *California*; Armored cruisers, not sheathed, *Maryland*, *Colorado* and *South Dakota*; Protected cruisers not sheathed, *St. Louis*, *Milwaukee* and *Charleston*. Accompanying the paper is a magnificent collection of drawings of the proposed vessels.

DISCUSSION.

Alexander J. Maclean said that, after looking over the drawings, he was struck with the conservatism of the U. S. and foreign navies in the matter of equipment. He noticed that the old fashioned stock anchor had been retained. The German Navy had tried the stockless anchor and found it very effective, and he understood that a trial of an anchor of this sort had recently been made on a British battleship and it had proved very effective.

There was no further discussion.

ON THE LAUNCH OF A CRUISER AND A BATTLESHIP.

BY JAMES DICKIE.

The vessels referred to in the paper are a cruiser 344 ft. long, 52 ft. beam, and of 2,400 tons launching weight, and a battleship 348 ft. long, 69 ft. 3 in. beam, and of 4,100 tons launching weight. The building slips were constructed on a mud flat, the mud ranging from 70 to 85 ft. deep to hard pan. The flat was piled with Oregon pine, from 70 to 80 ft. long and 14 to 18 in. dia. at the butt. Each pile could readily support 20 tons. Capping on top was 12 in. by 12 in., joists 4 by 12 in., spaced 24 in. centers, and planking 4 in. thick. The Author had employed launching weights per foot of surface ranging from 1 1-2 to 3 1-4 tons successfully. As a lubricant, on weights from 1 to 2 tons, soft tallow; from 2 to 2 1-2 tons medium tallow; and from 2 1-2 to 3 tons hard tallow, is recommended. Over 3 tons almost pure stearine is required. Temperature has to be considered in selecting the lubricant, but on the Pacific coast no trouble is met in this respect. After long experience the Author has found tallow and soft soap the most satisfactory. As to inclination, he has used one in fourteen for small vessels, and one in twenty-four for large vessels, with ways laid concave and convex, according to circumstances. Launching curves are prepared to determine the length of ways necessary, so that the strain on the bottom will not be too great before the vessel is water borne at the after end, and also to determine the strain on the forward poppets, when the vessel lifts aft. Treating of the two launches separately, the Author says the keel of the cruiser was laid at an angle of one in twenty, with bottom of stern post 14 in. above high water. Keel blocks were spaced 5 ft. centers, with four bilge blocks and twenty-eight shores on each side—an average of 18 1-2 tons to each block and shore. Blocking under the ways was spaced 5 ft. centers for two-thirds the length of the sliding ways at the upper end. For the remaining one-third, and for about 20 ft. aft of the after end of the sliding ways, the blocking was spaced 2 1-2 ft. centers, and from thence to the lower end about 5 ft. centers. Oregon pine without heart was used for groundways and sliding ways; the former 10 in thick by 18 in. wide by 60 ft. long, and the latter 8 by 18 in. and the lower piece 10 in. by 18 in. The sliding ways were in 5 pieces. Groundways were laid straight at an angle of one in eighteen, as far as the piling extended —28 ft. aft of the heel of the storm post. From that point, 73 ft. farther out, the mud was planked over with plank 24 ft. long by 6 in. thick, laid crosswise. The ways were laid level transversely, and no side shores were used except to correct any side curvature of the timber. Cross ties 4 by 6 in. were fastened under the ways 30 ft. apart, to insure them remaining the proper width until the vessel came on them. In launching over mud, the vessel carries a wave of mud ahead of her, and it is better to fasten the ways directly to the planking, so that they will be the proper width when down to their proper level. If side shores are used and the ways rise up, the shores have a tendency to pull the ways out and the vessel drops between. No shoring inside the vessel was used. All packing and wedges were fitted, using a small block the thickness of the sliding way, so that they were greased before being put in place. The lubricant was tallow stearine, heated and laid on in an even coat scant 1-16 in. thick. Over this there was a layer of oil soap. The Author then describes the final preparations for launching in detail—sliding ways and dog shores. The launching weight of the cruiser was 2,400 tons, and of the moving part of the cradle about 34 tons, a total of 2,434 tons. The ways had an effective bearing surface of 17 3-8 in. by 274 ft. in length, making 793 1-2 sq. ft. ÷ 2,434 = 3.064 tons per sq. ft. The cost of labor and material for the launch was: Labor, $1,182.20 and material, $436.10, a total of $1,618.30, which equals 66 28-100 cents per ton weight. Lumber charged to the launch included only that bought for it; stock on hand that had been used before was not charged. On the day of the launch there were employed thirty carpenters, eight boys, ten laborers, eight riggers, the superintendent of the yard and the yard foreman. The time occupied was reckoned from "started to ram up" at 9.58 A. M., to "finish and let go" at 11.24 1-2 A. M., = 76 1-2 minutes actual working time and 52 minutes resting time. Describing the launch of the battleship, the Author says the keel was laid at an angle of one in twenty with the heel of the stern post touching the water at high tide. As the mud outside of the yard was too high to admit of planking on top of it, piles were used to the extreme end, and to reduce the cost the ways were laid on a curve. Eight inches rise of arc in 264 ft. was the curvature decided upon. This gave a mean inclination of ways in the length of the cradle, before the vessel started to move off, of one in twenty-one and a half, and at the extreme lower end, 88 ft. from the heel, an inclination of one in fourteen. Details of the keel blocks, launching ways, shores, etc., follow. The launching weight of the vessel was 4,100 tons and of the moving cradle 62 tons, a total of 4,162 tons. The total beaming surface was 1,621 sq. ft. or 2.57 tons per sq. ft. Costs of launching included: Labor, $3,541.70; material, $1,253.80, a total of $4,795.50, or $1.15 per ton weight. The launch from start to finish occupied 155 minutes, made up of 118 minutes actual working time and 37 minutes resting time. Accompanying the paper is a table of data of the launches described, also several diagrams, showing the plan of piling, launching curves for each ship, arrangement of timbers, guillotine, and photographs of the forward and after poppets.

DISCUSSION.

HERBERT C. SADLER, in a paper submitted to the Secretary, said: "The launch of a large vessel is one of the most serious engineering problems that a shipbuilder has to contend with, and it is only natural that the practice should vary in different places. Referring to the pressure per sq. ft. of ways, Mr. Dickie says that he has successfully launched vessels where this amounts to as much as 3 1-4 tons. This figure seems to be rather on the high side, especially for large vessels. It may be of interest to note that on the Clyde the greatest pressure allowed seldom exceeds 2.6 tons per sq. ft., and in general varies from 1.8 tons to 2.5 tons, the latter figure being the usual one for large merchant vessels and warships.

Even with this amount of surface, there is usually a considerable amount of smoke towards the end of the launch. The camber, which is in all cases convex towards the vessel, varies in large vessels according to the weight, from 9 to 20 in., 12 in. being a common amount. In a number of ship yards, especially those on the upper reaches of the river, every vessel has to be checked by suitable drag weights in order to prevent her running into the opposite bank. These are usually arranged so that the whole amount does not come into play at once. There is, of course, a considerable variation in the amount of this weight, depending upon the length of ship and breadth of river, but in general this varies from 3 per cent to 5 per cent of the launching weight. The declivity, which varies with the size of ship, is usually from one to twenty-four at the fore end, to one in sixteen, to one in fourteen at the after end, the mean declivity in the case of large merchant vessels and warships being about one in twenty to one in twenty-five. Without doubt, as Mr. Dickie says, tallow and soft soap form the best lubricant for launching ways, and in cases where other substances have been used the results have sometimes been disastrous. The saddles shown at the after end of the vessels are not usually necessary, as in the case of twin screw vessels sufficient support for the after poppets may be obtained from the bossing, and in any case this part of the structure is not subjected to the same stresses as the forward end."

THE SAFETY OF TORPEDO BOATS AT SEA AND IN ACTION UNDER VARIOUS CONDITIONS.

BY NAVAL CONSTRUCTOR LLOYD BANKSON, U. S. N.

This is a short academic paper written by the Author to accompany a series of charts and tables, which refer especially to the U. S. torpedo boats *Ericsson* (built) *Bagley, Barney* and *Biddle* (building). He endeavors to point out what may be expected to occur to these boats when they are seriously injured or in danger in bad weather, and what chances they may have of keeping afloat. Referring to the graphical presentation of the subject, the Author points out that the center of gravity of each torpedo boat is fixed, and the vessel seeks the water line which will bring the center of buoyancy vertically below the center of gravity for each supposed bilged condition. The data for the calculations presented by the Author were obtained from the Bonjean curves for each torpedo boat. These curves are simply a series of displacement curves for short sections of a vessel from stem to stern, each section being bounded by transverse planes at the forward and after ends, so that by drawing any water line for the vessel out of the regular longitudinal trim, the sum of the various displacements from the Bonjean curves will give the total displacement for any longitudinal difference in trim. In passing, the Author remarks that the Bonjean curves are essentially French, and he expresses surprise that so little attention is paid to the scientific methods of analysis employed by French constructors. From the plotted results, the Author draws the conclusion that the chances of total loss of a torpedo boat are not so desperate as one might be led to expect. Various emergency devices in the fire and engine rooms have, he believes, diminished the chances for fatalities there, and another source of safety to the boat, when hunting in couples or groups, is that the disabled boat can be toward quickly out of action, either bow or stern first, and by the use of ejectors and pumps be sufficiently freed of water to make leak stopping possible. In regard to the seaworthiness of boats, they usually have a large range of statical stability. The angle of vanishing stability varies from about 70 deg., in some boats, up to and beyond 90 deg., in the case of the *Ericsson*. The Author considers the shallow draft of some of our torpedo boats as carried to an extreme, and suggests that a deeper design be adopted so as to increase their stability and seaworthiness. As to the above water portion of the boat, the Author admits that in a rough sea there is little hope for a boat in which the deck or shear strakes, or both, are seriously cut up or injured, amidship, by shell fire. Another source of danger is driving these light constructions at full speed into a head sea. The result may be that bows will be stove in, bent or twisted, as has happened in practice. In the diagrams illustrating the effect of bilged compartments of the U. S. S. *Bagley*, etc., the draft at the normal loaded conditions is shown to be 4 ft. 6 in. forward and 8 ft. 8 1-2 in. aft. With the after engine and boiler rooms flooded and open to the sea, the change of trim gives a draft of 5 ft. 5 in. forward and 11 ft. 2 1-2 in. aft, but at no point is the deck below water. The boats are shown in various other positions, with forward, midship, and after compartments flooded; in some extreme cases the boats being partly submerged though still afloat.

This paper was read by title and there was no discussion. The meeting then adjourned.

Social Features.

On Friday night, November 16, the annual banquet of the Society was held at Delmonico's, with President Clement A. Griscom as toastmaster. There were about 150 members and guests present, and among those who responded to toasts were: Congressman Amos Cummings, Col. A. L. Snowden, Col. J. J. McCook, Lewis Nixon, Stevenson Taylor, Wm. McFarland and Ex-Engineer-in-Chief C. H. Loring, U. S. N.

On the day following those who had accepted the invitation to visit Cramps' Shipyard took a special train at Jersey City and were taken right through to the yard without change, the train being switched through the streets of Philadelphia for the convenience of those on board. The objective point of most of the visitors was the Cruiser *Variag*, which lay alongside the fitting out wharf. The entire vessel was open for inspection, and the guests were accorded a cordial welcome by the Russian naval officers who have overlooked the construction. The engines, of the torpedo boat type, and the American built Niclausse water tube boilers were of special interest, and the extensive electric generating plant and the Russian naval ordnance were thoroughly scrutinized and occasioned favorable comment. A special feature of the equipment was the metallic furniture with

which all the living quarters were furnished. In the afternoon the guests were entertained at luncheon in the mould loft by the builders. A pleasing incident of this was the splendid reception given by the gathering to the veteran engineer, Charles H. Haswell, who arrived after the others were seated. Later those who were returning to New York re-entered the special train in the yard and carried away very pleasant remembrances of this social feature of the eighth annual meeting.

CHIEF CONSTRUCTOR U. S. N.—Upon the retirement of Rear Admiral Philip Hichborn on March 4 next the position of Chief of the Bureau of Construction and Repair at Washington will be filled by Chief Constructor Francis T. Bowles, who is now in charge of the work at the New York Navy Yard. As Mr. Bowles was born at Springfield, Mass., in 1858, he will have reached the highest place in the engineering branch of the service at the age of forty-two. Mr. Bowles entered the Naval Academy at Annapolis in 1875, and was graduated as a cadet engineer with the highest honors. He was selected for a supplementary course in naval architecture abroad, and was appointed and assumed the duties of Assistant Naval Constructor in November, 1881. Mr. Bowles' professional attainments are of the highest order, and his great executive ability has been demonstrated in the management of the Portsmouth, (Va.) Navy Yard, and, later, at the Brooklyn (N. Y.) Navy Yard. Mr. Bowles is known professionally to a very large circle of engineers as secretary of the Society of Naval Architects and Marine Engineers.

POLLAK PRIZE.—In competition for the prize offered by the heirs of Mr. and Mrs. Anthony Pollak, of Washington, D. C., who were lost on the S.S. *La Bourgogne*, a number of models were exhibited at the recent Paris Exposition. The prize, $20,000, was sufficiently large to interest inventors in many different countries, and there were in all about 400 competitors. The committee of award included prominent naval officers and persons engaged in maritime affairs of various countries, and its members decided that none of the plans submitted warranted the award of the entire sum. A prize of $2,000 in cash and a gold medal was, however, awarded to Leopold Roper, a British naval architect. He exhibited two separate systems: one a new form of davit and steel lifeboat of a type recently installed on the Cunarder *Campania*, and the other a life raft of large capacity, which in times of safety is used as the navigating bridge of the ship. It has been decided to hold another competition some time in the coming year.

The tests of the new 12-in. naval gun carried out at Indian Head, last month, showed that the weapon is superior to any other gun of the same calibre yet constructed. With a charge of 360 lb. of smokeless powder, a muzzle velocity of 2,854 ft. a second was recorded.

Control of the yard of the Union Dry Dock Co., at Buffalo, N. Y., has been secured by the American Shipbuilding Co., which now operates all the lake yards, except the Craig plant, at Toledo, O., and the Jenks shipyard at Port Huron, Mich.

SMASHUP OF THE STARBOARD ENGINES OF THE AMERICAN LINER ST. PAUL.

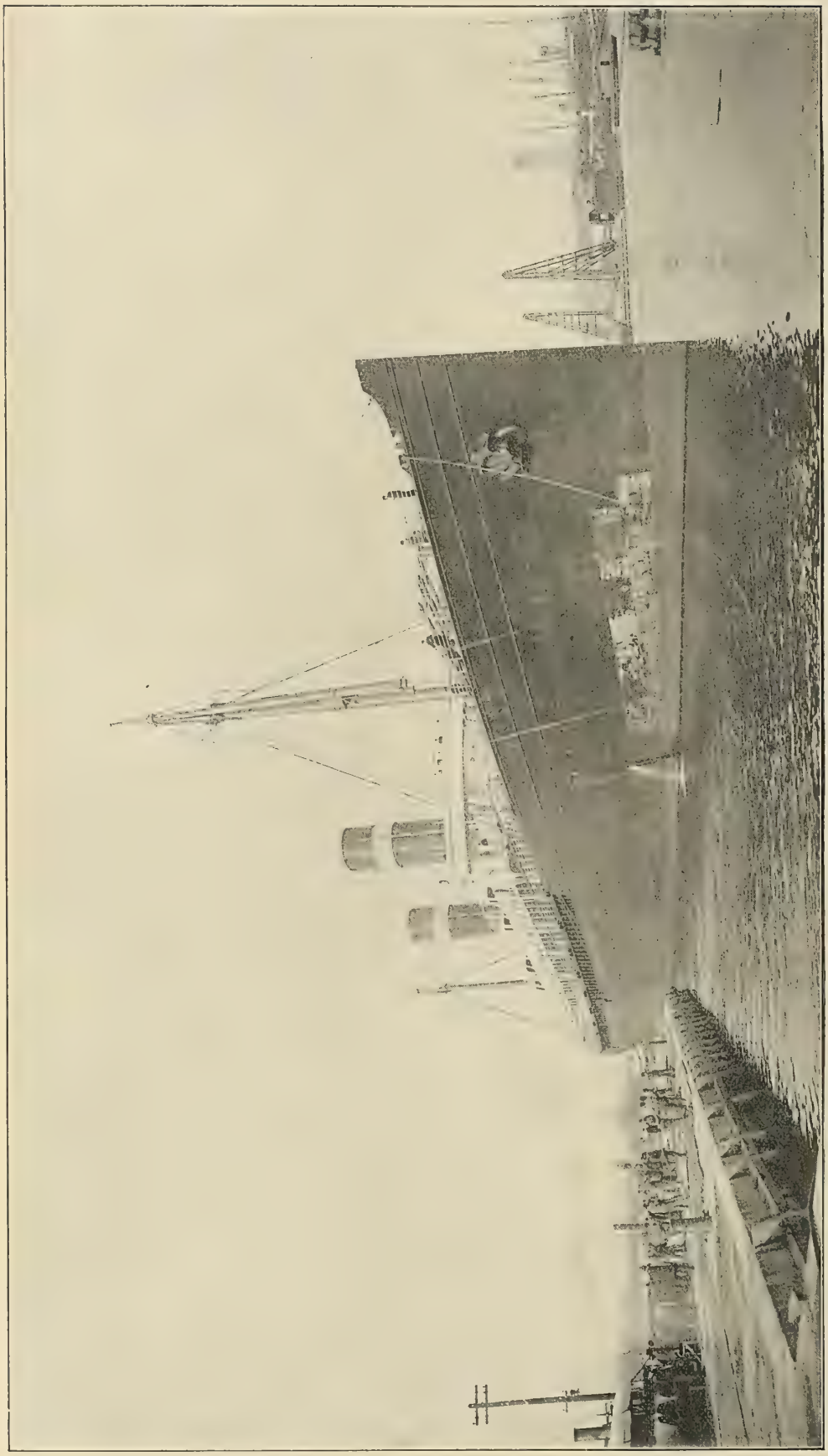
When the American liner *St. Paul* finished her last westward trip at New York, on November 4, she reported a serious mishap which had occurred in mid-ocean. Five days previously, at about 8 o'clock on the night of October 31, the vessel lost her starboard propeller and about 10 ft. of the tail shaft, and this was followed by a smash up in the starboard engine room, which, fortunately, did not cost any loss of life or jeopardize the safety of the vessel or those on board. The port propeller and engines were intact, and the vessel continued steaming westward at reduced speed. So slight were the manifestations of this mishap, and so perfect was the discipline of the crew, that few, if any, of the passenger realized at the time that anything unexpected had occurred.

The vessel had left Southampton October 27 with a full cargo and 316 cabin and 245 steerage passengers. Nothing whatever had occurred in either the engine or deck departments prior to the accident that would have given warning of possible disaster. At the time it occurred the position of the *St. Paul* was latitude 46.13 north, longitude 48.03 west—about half way across. There was a heavy sea running, and the vessel was moving about pretty lively, though making good time.

Just what occurred outboard and inboard is at this time, when the survey and adjustment are incomplete, largely a matter of conjecture. One theory is that the vessel struck a derelict in such a position that the starboard engine was brought up all standing, and the inertia forces coming into play caused a failure in the engine and shafting at the weakest points. The other and most generally credited theory is that the starboard propeller coming out of the water started the engines to racing, that a hidden flaw caused a fracture of the tail shaft and the engine, relieved of all load, ran away, the speed governor failing to act. Whatever may have been the cause, the result was that the forward end of the crank shaft lifted, stretching the main bearing bolts and cracking the engine seatings. The stretching of the bolts being greater than the cylinder clearances on top, the result was that the forward H. P. and L. P. pistons went through the heads and a general smash up was started, which, but for the presence of mind of the chief engineer, John Hunter, and assistant Gavin M'Coll, would probably have caused, at least, a repetition of the disaster which befell the S.S. *Paris* several years ago.

In the accompanying drawing the arrangement of the cylinders of the *St. Paul's* engines is shown. The engines are of the six cylinder, four crank, quadruple expansion type, the high pressure and low pressure ends being each split up into two separate cylinders for convenience. The high pressure cylinders are tandem over the low pressure cylinders at the forward end, the first intermediate being at the after end and the second intermediate between.

Just at the instant the shock caused by the propeller dropping off occurred the chief engineer was in the alleyway on the starboard side close to the galley, in which was an emergency gear connected with a stop



AMERICAN LINER ST. PAUL APPROACHING THE ENTRANCE TO THE DRY DOCK IN THE BROOKLYN, N. Y., NAVY YARD FOR SURVEY OF DAMAGE SUSTAINED.

Photographed for Marine Engineering by E. Muller.

valve on the steam main. With remarkable presence of mind, without stopping to make any inquiry as to the character or extent of the damage, he was instantly inside the galley and shutting off the steam supply to the engine. This, of course, would not bring the engine to a standstill immediately, as the large receiver spaces in multiple expansion engines contain enough steam to carry the engine over several revolutions; but already there was another cool head below in the person of Assistant Engineer M'Coll also thinking out the best means of preventing further damage. Mr. M'Coll was on the starting platform, and to get to the reversing lever was the work of a moment. Throwing the links into mid position, while the gear was still operative, he let steam into both ends of the still intact intermediate cylinders, and the engine was stopped. Meanwhile the work of destruction was going on, cranks were bending, running

gear twisting and straining, and even as he stood at the lever, one of the forward slides was wrenched from its

A quick examination showed that there was no rupture of the skin plating and that no appreciable

STERN VIEW AMERICAN LINER ST. PAUL IN NAVY YARD DOCK—STARBOARD PROPELLER MISSING.

Photographed for Marine Engineering, by E. Muller.

place on the column and hurled on to the platform, passing within a couple of inches of his body on its way.

amount of water was coming in at the stern gland. A proper speeding down of the fans at once con-

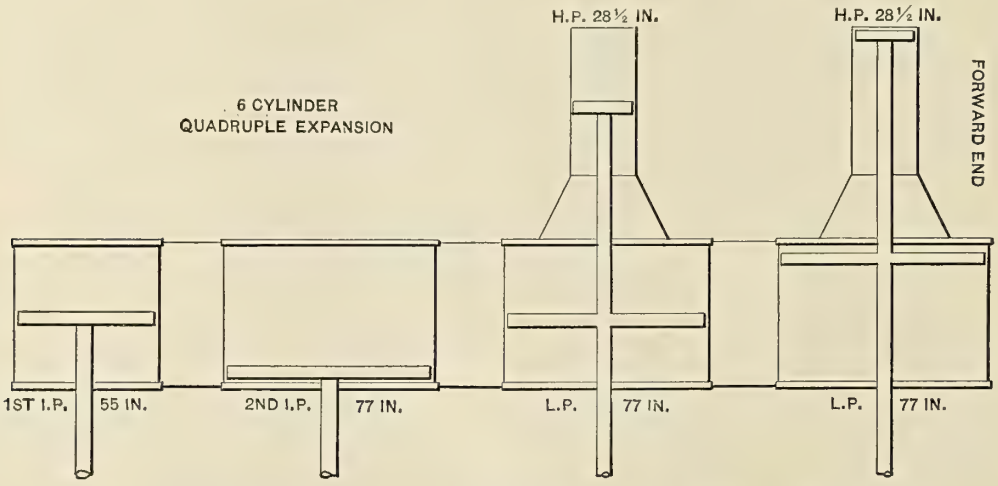
trolled the generation of steam in the boilers to the lessened demand and without stop or delay, other than the half power imposed, the *St. Paul* kept on her way to New York.

In engines of the type employed on the *St. Paul* governing by the throttle is impossible, and other automatic controlling apparatus is fitted direct to the reversing gear. Why the mechanism fitted on the vessel did not instantly respond to the decreased load has not been explained. Our readers will recall that on May 22 last, while bound west, the American liner *New York* dropped one of her propellers, and in that case the emergency gear instantly checked the engines and no inboard damage followed.

After the *St. Paul* reached New York permission was obtained from the government to dock her at the Brooklyn Navy Yard for an examination of the hull. In our engravings we show the liner at the dock entrance, and afterward in the dock with the starboard propeller missing. Little or no repairs were necessary in dock, and the *St. Paul* subsequently proceeded under her own steam to the yard of her builders (Cramps) at Philadelphia. The starboard engines will have to be taken adrift to determine just how much of the old work can be retained in the reconstruction.

It is particularly unfortunate that the mishap should have occurred at this time, when the *Philadelphia* (formerly *Paris*) is undergoing reconstruction, and not one of the new ships ordered by the line is ready for sea. Work on the Red Star liner *Vaterland*, now fitting out at Clydebank, will undoubtedly be rushed, so that the regular schedules of both the Red Star and American lines, operated by the International Navigation Co., may be maintained.

As a matter of convenience, we repeat the dimensions of the S.S. *St. Paul* and of her machinery. The dimensions are as follows: Length, 535 ft.; beam, 63 ft.; depth, 50 ft.; gross tonnage, 11,629. She is a steel twin screw vessel, built at Cramp's Shipyard, and she came out in the year 1895. The engines have cylinders—high pressure (two), 28 1-2 in.; first intermediate, 55 in.; second intermediate, 77 in.; and low pressure (two), 77 in. by 60 in. stroke. She has ten Scotch boilers, six double ended and four single ended, all of about 15 ft. 6 in. diameter. The boilers are worked with Howden draft, and the steam pressure carried is 200 lb. The engines are constructed with cast steel inverted Y columns, front and back, each column being made in halves, bolted together vertically. The high pressure piston rods are 6 in. dia. and the low pressure 8 1-2 in. dia. The connecting rods are 11 ft. 3 in. long between centers, 10 in. dia. at the crank ends, and 8 1-2 in. dia. at upper ends. The crank shaft bearings are 21 in. dia. and 31 1-2 in. long, with a 6 in. through hole. The piston rods are fitted with single slipper guides working in slides bolted to the inboard columns at the ends. The collective H. P. of the twin screw engines is about 20,000 I. H. P.



ARRANGEMENT OF CYLINDERS IN ENGINES OF AMERICAN LINER ST. PAUL.

CONDITIONS OF AMERICAN SHIPPING AS DISCLOSED IN U. S. OFFICIAL REPORT.

There is much encouragement for those who are doing the pioneer work in restoring the American merchant marine to its proper position among the merchant navies of the world in the report of the U. S. Bureau of Navigation for the past fiscal year, which will shortly be issued. An abstract of this report has been issued by Commissioner E. T. Chamberlain, which brings out many interesting points, both as to the actual condition of the merchant marine and as compared with the fleets of other nations.

"For the first time since the Civil War broke out the documented tonnage of the United States exceeds 5,000,000 gross tons. On June 30, 1900, American documented tonnage comprised 23,333 vessels of 5,164,839 gross tons, an increase of 300,000 tons over the previous fiscal year. Our maximum tonnage was 5,539,813 tons in 1861. (Our shipping was then larger than Great Britain's, and nearly equaled the British Empire's. British shipping now amounts to 14,261,000 gross tons.)

"American vessels are almost wholly confined to the coasting trade, which employed last year 4,338,145 tons, or more than the total tonnage of Germany and France. Our tonnage in the foreign trade was only

816,795 tons, and carried last year only 9 per cent of our exports and imports. A century ago American shipping registered for foreign trade was 669,921 tons, while this tonnage now in the 13 original States amounts to 482,907 tons.

"For serious competition with foreign nations in the ocean carrying trade we are practically restricted to 97 registered steamships over 1,000 tons, aggregating 260,325 tons. Single foreign steamship corporations own greater tonnage. Japan has 83 ocean steamships of over 2,000 tons, aggregating 286,000 tons. Besides these steamships we have 125 registered square-rigged sail vessels over 1,000 tons each for the deep-sea trade. More than half of these are over 20 years old, and as such vessels disappear their places are not supplied by new construction.

"Our tonnage is distributed, between the Atlantic and Gulf coasts, 2,727,892 gross tons; Great Lakes, 1,565,587 tons; Pacific Coast, including Hawaii, 612,904 tons; Mississippi and tributary rivers, 258,456 tons. Our steam vessels amount to 2,657,797 tons; documented canal boats and barges to 622,000 tons; and the remainder, 1,884,842 tons, are sail vessels and schooner barges.

"The increase in our shipping during the decade was 740,342 tons, of which 502,523 tons stand to the credit of the Great Lakes. The increase in ten years on the Pacific has been 184,512 tons, due mainly to Alaskan and Hawaiian trade, and on the Atlantic and Gulf Coasts only 89,297 tons, while the tonnage on the Mississippi and tributaries has decreased 36,000 tons.

"The report is chiefly devoted to the relations of the United States to the world's ocean carrying trade, and for this purpose changes in the world's shipping during the past ten years are examined in some detail. Since 1890 the world's steamships have increased from 12,985,000 gross tons to 22,369,000 gross tons, sail vessels have decreased from 9,166,000 tons to 6,674,000 tons, and the effective carrying power of the world's merchant fleets has increased 60 per cent.

"The most notable change in the world's shipping has been in the size of steamships. In 1890 there were 218 ocean steamships of 4,000 tons or over, while now 980 such steamships, aggregating 5,600,000 tons, constitute one-fourth of the world's steam tonnage.

"Increased speed, though great, has been less noteworthy. Of the ocean steam tonnage of 1890, 13 per cent, 423 screw steamships, of 1,650,000 tons, were of 12 knots or over. Of ocean steam tonnage in 1900, 24 per cent, 1,109 screw steamships, of 5,230,000 tons, are of 12 knots or over. The hulls of 60 per cent of the world's shipping are now made of steel.

"Concentration of the world's shipowning has been as notable during the decade as the centralization of shipbuilding. A list is printed of the 30 principal steamship companies of the world which own 1,600 steamships of 5,616,000 gross tons (including some vessels now building), or one-quarter in tonnage and more than one-quarter in carrying power of the world's ocean steamships. Of these only nine, of 81,000 tons, owned by the International Navigation Company, are American. Ocean carrying, through regular passenger and freight lines, is being assimilated to the methods and conditions of trunk railroad transportation.

"On the basis of the gross earnings reported by principal foreign steamship companies it is estimated that during 1899 the gross earnings of steam and sail vessels in the foreign carrying trade of all nations amounted to $700,000,000.

"The export trade of the United States requires about 20 per cent of the world's seagoing tonnage in foreign trade, including the largest, fastest and most expensive steamships. The weight of our exports by sea in 1899 was 24,000,000 tons, of 2,240 lb. To carry these exports and passengers, including immigrants, requires steady employment throughout the year of about 1,200 steamships aggregating 3,600,000 gross tons, and 1,300 sailing vessels of 1,000,000 tons. The number and tonnage of vessels actually engaged is, of course, larger, as, obviously, many vessels are engaged only part of the year in the trade of the United States.

"In the past ten years Great Britain has built 4,638 steel steamships of 9,793,000 tons, while the United States has built 465 steel steam vessels of 743,000 tons, of which 198 of 450,000 tons were built on the Great Lakes. Our entire construction for the decade is not much more than half of Great Britain's output of 1,340,000 tons during 1899. We have built for the foreign trade since 1890 only twenty-four steel steamships of 80,000 tons, and of this total eleven steamships of 58,000 tons were built as mail steamships under the postal subsidy acts.

"On August 15, 1900, sixty-eight steel merchant steam vessels, aggregating 278,000 tons, and forty-seven naval vessels, 113,000 tons (displacement), were building or contracted for. Contracts since that date (some since election not included in the report) bring the merchant total up to 350,000 tons, including about 100,000 tons on the Lakes. Congress has authorized 179,800 tons (displacement) of naval vessels, not yet contracted for. Part of the merchant construction will not be completed in two years or more, but the current year will record much the largest amount of steel shipbuilding in our history.

"A freight steamship carrying 5,000 tons cargo now costs $275,000 in the United States, compared with $214,0000 in Great Britain, though steel is much cheaper here than abroad. Besides lower labor cost, the British advantage lies in the enormous scale of production, Great Britain being the world's department store of shipping. Monthly wages on the American vessel are $1,200 against $900 on the British ship.

"On the basis of foreign voyages actually made by American vessels, aggregating 809,000 gross tons, during the calendar year 1899, the expenditures under the Senate subsidy bill would have been $2,907,000, and under the House bill, $2,790,000. Details and estimates show that, with the additional shipping eligible, the cost during the first year of the bill's operation would be about $4,500,000. The maximum of $9,000,000 would probably be attained during 1904-5, when a reduction of subsidy rates would be necessary. By that time the building of over 500,000 tons of ocean steamships, and the necessary increase in number and extent of our shipyards, would have materially reduced the cost of shipbuilding in the United States, compared with Great Britain and Germany. Under the bill, in five years, American steamships in foreign trade would, it is estimated, reach 1,200,000 tons, and sail vessels 650,000 tons, sufficient to carry about one-third of our ocean trade."

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

AS our readers will have observed, this issue contains a detailed account of the proceedings at the eighth general meeting of the Society of Naval Architects and Marine Engineers, which was brought to a successful though somewhat abrupt conclusion, so far as the technical sessions were concerned, on November 16. The real cause of this unusual endi g was the reading of a scurrilous attack upon the Author of a scientific paper by no less a person than a Member of the Council of the Society. After the paper on "Classification Rules" had been opened for scientific discussion the Member of the Council, who is also an official of the American Bureau of Shipping, rose to reply, and proceeded to read from a document which contained little of technical value but much of personal abuse and insult directed at the Author of the paper. More amazing still is the fact that the reading of this document passed unchallenged by the Chair or by any member present in the convention hall. At its conclusion the Author, who had kept a dignified silence, arose and, ignoring the insults and insinuations, confined himself to legitimate discussion. A more detailed account of this discussion will be found in our report of the meeting, though this has been expurgated. After some further discussion this Member of the Council had the effrontery to offer a motion, "in view of the misstatements and untruthfulness of the paper," that it and the "remarks" bearing upon it be excluded from the proceedings. This motion met, of course, with no support, but apparently prompted another motion, which was carried, that leave be given the Author of the paper and those who took part in the discussion to "eliminate personal remarks." This was adding injury to insult with a vengeance. This motion should never have been put in the form it was made in, and its passage was a public affront, not only to the Author of the paper, but to the distinguished Secretary of the Society. In the first place, there are no personalities contained in the paper, and in the second place, it has been the duty and privilege of the Secretary to see that papers presented are in accord with the ethics of the honorable profession of which he is a member. Then it was only a few hours previously that the President rightly assured the Meeting that the papers to be read "had been prepared by gentlemen whose abilities command the highest professional esteem," and the Society stultified itself by passing an omnibus order which classes the Author with one whose grossness of attack might have called out denunciation in a gathering of political heelers. In any view of the matter, what good purpose could be served by such a motion? Were a man so little a judge of the decencies of speech that he would use insult instead of argument unknowingly, how would he be put in a position to write politely by such an indefinite order? Were he blameless of any wrong doing the necessity for such order would not exist. In any rational consideration of such an offense it would in the first instance be necessary to particularize and point out to his vulgar comprehension the objectionable passages for excision, and in the other case the granting of such permission would be a gratuitous insult that might be resented, under certain readily conceivable circumstances, with Nature's weapons. And in the case of one who deliberately and with malice violated his confidence as an officer of the Society, and grossly outraged the hospitality which the Society should extend to members contributing to its proceedings, some disciplinary treatment would be in order. The Council of

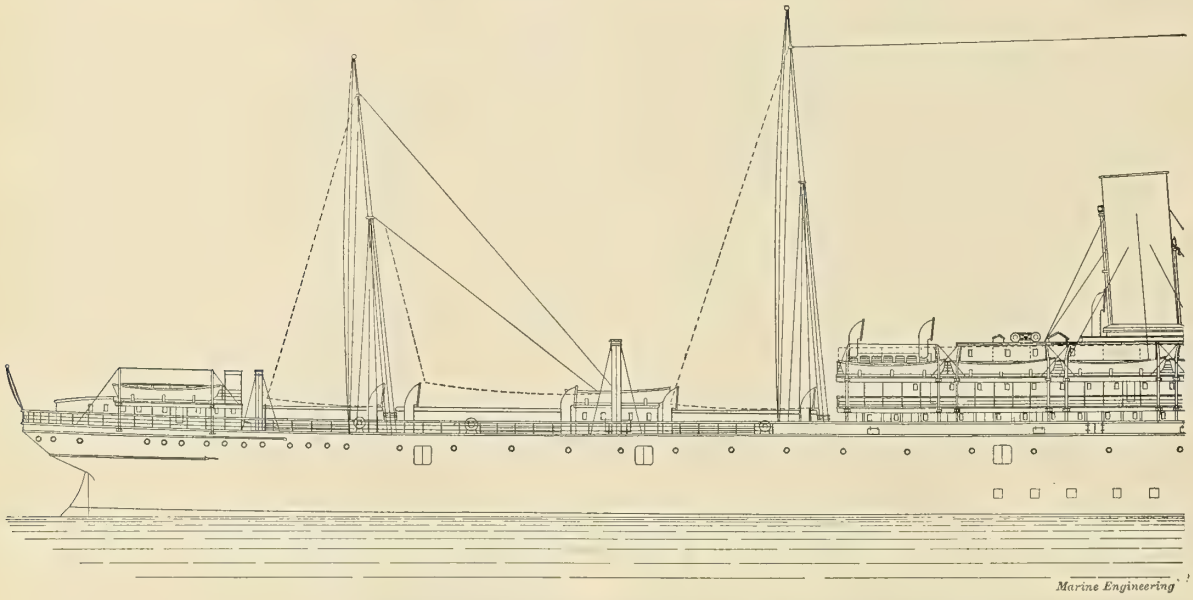
the Society owes it to itself, and to the dignity and standing of the S. N. A. and M. E. among the kindred societies of the world, to probe this matter further and place itself on record as to the treatment to be accorded those Authors who decently attempt to add to the value of the Proceedings.

IT is the fashion among certain writers to bewail the disappearance of the "lofty masts and tapering spars" from the fleet ships of commerce, and to associate with this the decline of the poetry and romance of the seas. It is as well, perhaps, that they have gone, in large part, in the days of the "strenuous life," but in their place have come new forms in naval architecture and new types among those who go down to the sea in ships that in their own day and age have all the beauties and virtues of their predecessors. Some time the poet and the prose writer will awaken to this and in undying art will tell of the days of steam. We are put in this humor of thinking by contemplation of the act of Assistant Engineer M'Coll, of the American S.S. *St. Paul*, on her last westward trip. Fortune favored that ship when, by a seeming chance, Gavin M'Coll stood on the starting platform in the starboard engine room on that night of October 31. During the watch there had been no warning of coming danger. The engines were turning up with the smoothness for which the machinery of this and her sister ship are famous in the transatlantic trade. Then, in an instant, there was a shock, a startling interruption of the smoothness of rotative effort, and ten thousand horse power was turned loose in the cramped space of a liner's engine room. Down below the water line, alone, caged with an engine that, like some maddened prehistoric monster, was tearing its own members asunder, Engineer M'Coll had his choice. Through the door at his back, in the bulkhead, and up the port ladders lay immediate safety for himself, but what of the ship? He knew that over his head a seventeen-inch steam main might, if ruptured, boil him alive with two hundred pounds of steam, or that, pinned down by some of the falling machinery, he might drown like a rat in a flooded sewer were the sea connections carried away. A veteran, he well knew the risks, and he also knew what the safety of the ship and of her passengers demanded—his life, possibly. And with as much coolness and attention as though the order "Stand by!" had just been rung down before leaving the dock, he shifted the links and the uncontrolled forces were stilled. Even as he stood at the quadrant a half ton of metal passed within a hand's space of his body with the velocity of a projectile. In the day of battle, when the spirit of patriotism is aroused, when comrades in arms are joining in the common cause and the old flag is flying over head, a man will do a heroic deed that in calmer times he might find impossible. There was no such inspiration for Engineer M'Coll. Alone with unexpected disaster, with forces of enormous magnitude ready to overwhelm him, he faithfully performed his duty. We did not read of any testimonials prepared by grateful passengers, nor any official expressions of appreciation, though many a man has won the Thanks of Congress or the Victoria Cross for less. It would be fitting for the underwriters to take such action, and in a public place, say the floor of the Maritime Exchange, present to Gavin M'Coll some tangible sign of acknowledgment.

NOW that the Paris Exposition is a thing of the past, attention to such displays will be centered upon the Pan-American Exposition at Buffalo, New York, which will open its gates to the public May 1 next. Already the grounds and buildings have taken such shape that the magnificence and beauty of this all-America fair can be appreciated. A most interesting booklet has been issued by the management, giving details of the project and containing copies of photographs of the buildings and grounds, and those who have not examined this publication will benefit themselves by procuring a copy from the headquarters at Buffalo. Although the Exposition has been located outside of the principal cities of the country it will be of the first magnitude, its cost exclusive of the exhibits being estimated at ten million dollars. The location has the great advantage of being readily accessible by railway and by water transportation. At the Exposition there will be twenty or more main buildings, and the exhibits will be divided into about as many classes. Owing to the nearness of the Niagara Falls electric power plant, the management will be able to make a magnificent electric display which will include many new and beautiful effects. We hope the marine interests of the country will be worthily represented.

OCEAN STEAMSHIPS BUILDING FOR J. J. HILL AT NEW LONDON, CONN.

Many large passenger and cargo steamships have been built during the past few years. The *Campania* and *Lucania* of 12,950 tons gross register, the giants of 1893, have recently been dwarfed by such tremendous vessels as the *Kaiser Wilhelm der Grosse* of 14,349 tons, the *Deutschland* of 16,000 tons, and the *Oceanic* of 17,000 tons. Vessels are now being built in Europe that will exceed in size all the above mentioned; but not any of these steamships of which we can obtain accurate information, either built or projected, will equal in tonnage, displacement or carrying capacity the mammoth Pacific liners building for the Great Northern Steamship Company, by the Eastern Shipbuilding Company, of New London, Conn. These large new vessels, of which the keels are already laid, have been designed primarily for cargo carriers. They are not as long as some of the largest Atlantic liners, but are much wider and deeper. The following are their principal dimensions: Length, 630 ft.; beam, 73 ft. 6 in.; depth, 55 ft. 8 in.



OUTBOARD PROFILE OF THE TWO OCEAN GOING STEAMSHIPS (33,000 TONS DISP.) UNDER

These immense vessels will be of about 21,000 gross tons register and 33,000 tons displacement, or just 10,000 tons more displacement than the new Atlantic liner *Deutschland*. They have each five continuous decks extending the whole length of the ship, with three additional decks amidships.

The cubical carrying capacity of these ships is very great, and the holds are such that 28,000 tons of coal can be carried, excluding 4,500 tons carried in permanent bunkers. The dead weight carrying capacity at normal draft is stated as 20,000 tons. The vessels are fitted up for the accommodation of a large number of passengers. About 200 first cabin passengers will be carried in the amidship houses; 100 second cabin just abaft of the machinery below the weather deck; 200 third class forward of the machinery; and in the forward between decks, accommodation will be provided for about 1,000 steerage. As the crew will number about 250 men all told, the total number of berths fitted for the passengers and complement will be about 1,750.

Each vessel has a double bottom extending the whole length of the ship, over 6 ft. deep, and this is divided up into about thirty compartments. The main hull above the double bottom is divided up into twenty-five compartments, the vessel being practically unsinkable. Deep water tanks have been fitted in the between deck spaces for lessening stability at light draft and making the vessel easier in a seaway. Arrangements have been made for carrying cattle, also for chilled or frozen meats in refrigerating chambers, and fruit or any kind of cargo that may appear for transportation. As shown by the accompanying profile, the vessels have a very pleasing and business-like appearance. They resemble somewhat the latest steamships built by Harland & Wolff, of Belfast, for the Atlantic intermediate carrying trade. The vessels have got substantial freeboard, four masts and one smoke pipe, well located and harmoniously arranged. For cargo carriers and money earning vessels, they are shapely, handsome vessels.

The propelling machinery consists of twin screws, vertical triple expansion surface condensing engines, with cylinders about 30 in., 54 in. and 90 in. by 54 in. stroke.

Steam will be generated by sixteen large water tube boilers of the Niclausse type, worked at forced draft. These boilers have a heating surface of over 40,000 sq. ft. The working pressure is 250 lb.

The general arrangement and details of these vessels are of particular interest, and interesting innovations can be seen on every hand. They are purely an American production, of American design and American construction, and will be owned and operated by an American steamship company. They will carry

the produce of the western farms, mines and manufacturing companies of this country and distribute the same wherever there is a demand in the Orient.

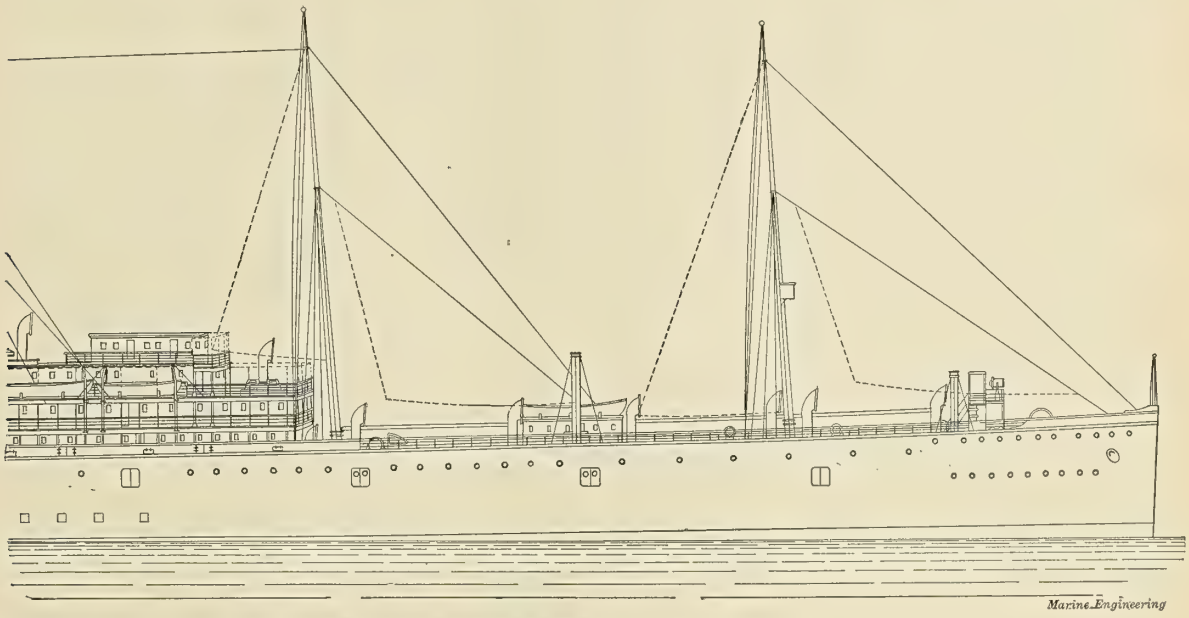
The Eastern Shipbuilding Co., the builder of these mammoth vessels, is now completing the construction of a modern shipbuilding plant on the Thames river, opposite New London, Conn. The officers of the company are: Charles R. Hanscom, president; John Sherner Hoyt, treasurer; William A. Fairburn, naval architect and engineer; Charles Schofield, yard superintendent. The new Pacific liners are expected to be completed for the summer of 1902, and they will cost about $2,500,000 apiece.

NEW WHITE STAR LINER CELTIC.—Advices from Belfast, Ireland, report that work on the new monster vessel for the Liverpool-New York service of the White Star line is so far advanced that she will probably be launched before the close of the year. She is

LAUNCHES—HOME AND FOREIGN.

U. S. S. ARKANSAS.—The monitor *Arkansas* was launched at the yard of the Newport News Shipbuilding & Dry Dock Company on November 10. The boat was christened by Miss Bobbie Newton Jones, daughter of Governor Jones, of Arkansas. Her dimensions are: Length on load water line, 252 ft.; extreme breadth, 50 ft.; mean draft, 12 ft. 6 in.; displacement, 3,235 tons; gross tonnage, 1,613.27 tons. Her armament consists of two high power 12-in. breech-loading rifles, a gun that has just been designed to be used with smokeless powder; four 4-in. rapid fire breech-loading rifles completing the main battery. The secondary battery consists of three 6-pdrs. rapid fire and four 1-pdr. automatic rifles. The *Arkansas* is one of four harbor defense vessels of the monitor type authorized by act of Congress of May 4, 1898.

S.S. GEORGETOWN.—The steel propeller *Georgetown*,



CONSTRUCTION AT THE YARD OF THE EASTERN CONSTRUCTION CO., FOR J. J. HILL.

modeled after the *Oceanic*, and will have a somewhat similar appearance in the water, with two funnels, but will have four masts. Her gross measurement is 20,000 tons, which is 3,000 greater than the *Oceanic*. The boat, we are informed, will come under the intermediate class, and so will not break any transatlantic speed records.

According to Lloyds, there were 452 vessels of 1,204,008 tons built in the United Kingdom during the quarter ending September 30, 1700. This shows a reduction of over 60,000 tons as compared with the similar period in the year 1899. These figures do not include war vessels.

In his annual report, Rear Admiral Bradford, U. S. N., Chief of the Bureau of Equipment, recommends the installation of the Marconi system of wireless telegraphy on several U. S. naval vessels, provided the cost is not excessive.

the first ocean going boat ever built at Buffalo, was launched at the yard of the Union Dry Dock Co., Buffalo, N. Y. She was built for the Atlantic Coast Steamship Co., of New York, and is of these dimensions: Length, 258 ft.; beam, 40 ft.; moulded depth, 18 ft. 3 in. She is fitted with triple expansion engines and Scotch boilers. The *Georgetown* is a sister ship to the *Waccamaw*, which was built at Toledo.

U. S. S. PERRY.—The torpedo boat destroyer *Perry* was launched from the Union Iron Works, San Francisco, Cal., Oct. 27, the ceremony of christening being performed by Miss Maud O'Connor. The dimensions are: Length on load water line, 245 ft.; extreme breadth, 23 ft. 7¼ in.; mean draft, 6 ft. 6 in.; displacement, 420 tons, and gross tonnage, 508.93 tons. Her engines are twin screw of vertical inverted triple expansion type, and the boilers are Thornycroft water tube. She will carry two 3-in. R. F. guns, five 6-pdrs., and two 18-in. torpedo tubes.

U. S. S. Nevada.—The monitor *Nevada*, one of the four vessels of this class authorized by Congress in May, 1898, was launched at the yard of the Bath Iron Works, Bath, Me., last month. She was christened by Miss Annie Boutelle, of Bangor, daughter of Congressman Boutelle. This vessel was originally named the *Connecticut*, but owing to objections raised by the people of that State, who disapproved of the use of the name on a vessel of this type, the name was subsequently changed to the *Nevada*. This monitor is a sister ship of the *Arkansas*, *Florida* and *Wyoming*. She is of about 3,000 tons displacement and will carry two 12-in. guns and four 4-in. guns in the main battery. The contract date of completion is March 19, 1901.

U. S. S. Lawrence.—The torpedo boat destroyer *Lawrence* was launched at the yard of the Fore River Engine Co., at Weymouth, Mass., on November 7. The boat was christened by Miss Ruth Lawrence, a descendant of the naval hero, Commodore Lawrence, after whom the boat was named. The *Lawrence* is one of the sixteen destroyers authorized by Act of Congress of March 4, 1898, and is of these dimensions: Length on load water line, 242 ft. 3 in.; extreme beam, 22 ft. 3 in.; mean draft, 6 ft. 2⅛ in.; displacement, 400 tons, and gross tonnage, 431.20 tons. Her armament will consist of two long 18-in. Whitehead torpedo tubes, two 14-pdrs. and five 6-pdrs. R. F. guns.

Japanese Battleship Mikasa.—The Japanese battleship *Mikasa* was launched on November 8 at the Vickers-Maxim Works at Barrow, England. The *Mikasa* is of 15,200 tons displacement; she is 400 ft. long, 76 ft. wide, 27 ft. 3 in. deep. She has two propellers, and engines of 15,000 I. H. P. Her armament consists of four 12-in. guns, fourteen 6-in. quick firing guns, twenty 12-pdrs., eight 3-pdrs. and four 2-pdrs. She has four submerged torpedo tubes. The battleship has an estimated speed of 18 knots, and her normal coal supply is 1,400 tons. She carries a crew of 730 men. The *Mikasa* was christened by Baroness Hayashi, wife of the Japanese Ambassador to England.

U. S. S. De Long.—Mrs. Sophie De Long Miles went through the formality of naming the *De Long* on November 22, at Lawley's ship yard, South Boston, Mass., although the boat was not launched, the water at high tide being too low. She was launched privately on November 23. The *De Long* is one of the eight torpedo boats ordered by the government in the fall of 1898. She is named for George Washington De Long, Lieutenant-Commander of the U. S. Navy, the Arctic explorer. The vessel's dimensions are as follows: Length on load water line, 175 ft.; extreme breadth, 17 ft. 6 in.: mean draft, 4 ft. 8 in.; displacement, 165 tons; gross tonnage, 226.18 tons.

S.S. Orion.—The wooden steamship of about 3,000 tons capacity was launched recently at Green Bay, Wis. Her dimensions are: Length over all, 282 ft.; beam, 42 ft. 23 in.; depth amidships, 16 ft. The hull is very strongly braced with steel members, and the vessel will have eight hatches and two masts. She will be fitted by compound engines built by H. G. Trout, of Buffalo, and a Scotch boiler built at Ferrysburg, Mich.

Ferry Boat West Point.—The ferry boat *West Point* for service in connection with the West Shore Railroad in New York harbor was launched at the ship yard of Thomas S. Marvel & Co., Newburgh on the Hudson, November 10. The vessel is built of steel and will be fitted with double screws—one screw at each end. Her dimensions are: Length, 208 ft.; beam, 40 ft.; depth of hold, 18 ft. She will be fitted with vertical engines and boilers of the Scotch type. The machinery is being constructed by the W. & A. Fletcher Co., Hoboken, N. J.

Tug S. R. Callaway.—The steel tug *S. R. Callaway*, built for the Vanderbilt railroad interests, was launched at the yard of Thomas S. Marvel & Co., Newburgh on the Hudson, November 10. Miss Callaway, daughter of the president of the New York Central Railroad, christened the boat with the customary bottle of champagne. The tug is of these dimensions: Length, 105 ft.; beam, 24 ft.; depth of hold, 11 ft. She will be fitted with compound engines 20 in. and 40 in. by 26 in., and will be used both for inside and outside towing in New York harbor.

S.S. Hawaiian.—The big freighter *Hawaiian* of the American-Hawaiian Steamship Company was launched at Roach's ship yard, Chester, Pa., on November 7. Mrs. W. C. Sproul, wife of the State Senator from Delaware county, christened the vessel. The new boat is one of a fleet of seven steamers. Her dimensions are: Length, 435 ft.; beam, 51 ft.; depth, 33 ft. to water bottom. Her gross tonnage will be 6,000, and she is fitted with triple expansion engines of 2,500 H. P., and will carry 8,250 tons of freight.

U. S. S. Blakely.—The torpedo boat *Blakely* was launched on November 22 at the works of George Lawley & Son, South Boston, Mass. The *Blakely* is named for Captain Johnston Blakely, who became famous as commander of the fighting ship *Wasp* in the war of 1812. She was christened by Miss Nellie M. White, of Winchendon Springs. The dimensions are: Length on load water line, 175 ft.; extreme breadth, 17 ft. 6 in.; mean draft, 4 ft. 8 in.; displacement, 165 tons; gross tonnage, 224.18 tons.

S.S. General Frisbie.—Steamer *General Frisbie*, built for the Monticello Steamship Company of California, was launched at the Bellingham Bay Improvement Company's yard, New Whatcom, Wash., on November 15. The dimensions of the *General Frisbie* are as follows: Keel, 160 ft.; over all, 170 ft.; beam, 25 1-2 ft.; hold, 13 ft.; H. P. of engines, 1,200. She is designed for a fast day excursion boat and will carry 800 passengers.

S.S. Runic.—The steamship *Runic*, building for the White Star Line, was launched at the yard of Harland & Wolff, Belfast, Ireland, October 25. The *Runic* is designed for trade between England and South America and Australia, and is one of the largest passenger steamers afloat. She is of these dimensions: Length, 565 ft.; beam, 64 ft.; gross tonnage, 12,400 tons.

Tug Chauncey M. Depew.—The seagoing tug *Chauncey M. Depew*, the companion boat to the *S. R. Callaway*, was launched November 27 from the ship yard of Thomas S. Marvel & Co. The *Depew* is 105 ft. long, 24 ft. beam, and 11 ft. 9 in. deep.

H. M. S. Racehorse.—H. M. S. *Racehorse* was launched on November 8 from the Hebburn shipbuilding yard on the east coast of England. The *Racehorse* is one of three similar vessels now under construction, and is one of the latest type of torpedo boat destroyers. Her length is 210 ft.; breadth, 21 ft.; depth, 12 ft. 6 in., with a displacement of 316 tons. The armament consists of one 12-pdr. and five 6-pdr. quick firing guns, and two deck torpedo tubes.

Sch. Louise B. Crary.—The five masted schooner *Louise B. Crary* was launched from the yards of the New England Shipbuilding Company, Bath, Me., on November 20. She was christened by Mrs. Louise B. Crary, wife of T. B. Crary, one of the principal owners, of Binghamton, N. Y. The vessel's dimensions are: Keel, 250 ft.; beam, 46 ft.; length of masts, 115 ft.; gross tonnage, 2,331.

S.S. John J. Albright.—A 6,000 ton steel steamer built by the American Shipbuilding Co., at Cleveland, for Captain John Mitchell and associates, was launched November 3. This vessel measures: Length, 436 ft.; beam, 50 ft.; depth, 28 ft. She will be fitted with triple expansion engines, with cylinders 23 in., 37 1-2 in., and 63 in. by 42 in. stroke, and with three Scotch boilers.

Dredge Seattle.—The dredge *Seattle*, which is probably the largest and most expensive dredger ever constructed on Puget Sound, was launched from the yard of the Seattle Bridge Co. recently. She is to be used in the Government dredging of Everett harbor. The *Seattle* is of these dimensions: Length, 145 ft.; beam, 34 ft., and 12 ft. 6 in. between deck and keel.

Floating Dock.—A large sectional dry dock was launched recently from the yards of the Brewer Dry Dock Company at Elm Park, Borough of Richmond, Staten Island. It was the first dry dock ever built on Staten Island. The dock is 176 ft. long, with outriggers of 30 ft. on either side, and is 80 ft. wide and 35 ft. high, with a lifting capacity of 2,500 tons.

Sch. Oliver J. Olson.—The four masted schooner *Oliver J. Olson* was launched at Lindstrum Bros.' shipyard, Aberdeen, Wash., on November 10. She was christened by Miss Anna Knudson, one of the city's school teachers. The dimensions of the schooner are as follows: Length, 188 ft.; breadth, 38 ft. 6 in.; depth of hold, 14 ft.; displacement, 650 tons.

Sch. Clifford N. Carver.—The four masted schooner *Clifford N. Carver* was launched from the yard of the New England Co. at Bath, Me. She was christened by Miss Myrtle Thompson. The new vessel is of these dimensions: Length, 173 ft.; beam, 39 ft.; depth, 18 ft.; gross tonnage, 1,100 tons. The *Carver* is intended for coastwise trade.

Launch Major Symonds.—A wooden hull steam launch for the use of the U. S. Engineer of Buffalo, N. Y., was launched at the yard of Hingston & Woods last month. This boat is 68 ft. in length and will be used in connection with the harbor improvement work at Buffalo.

Sch. Ella F. Cripps.—The large bay schooner *Ella F. Cripps* was launched at the yard of Kirby & Sons, St. Michaels, Md., on November 2.

Barges Loyalty and Liberty.—Two steel tow barges for use in salt water trade to accompany the steamships *Paraguay* and *Ascunsion* were launched recently at West Superior, Wis. The steamships and barges are under the management of A. B. Wolvin, of Duluth, Mich. They will probably be put in service in the coast coal trade.

Sch. Republic.—The schooner *Republic* was launched from the ship yard of Dunn & Eliot, Thomaston, Me., on November 7. She was christened by Miss Ida Elliot, daughter of the builder. The *Republic* is a staunchly built vessel, and her dimensions are as follows: Length, 174.4; breadth, 38.2; depth, 17.9; gross tonnage, 801.95.

Dredge Sabine.—The U. S. twin screw hydraulic dredging ship *Sabine* was launched from the new ship yard of the Townsend & Downey Shipbuilding & Repair Co., Shooters Island, N. Y., on Nov. 24. This vessel will be used in connection with the work of harbor improvement at New York.

S.S. Indian.—The steamer *Indian* was launched at Belfast, Ireland, recently for the West India & Pacific Steamship Company. The steamer was specially built for the New Orleans-Liverpool trade. She is 482 ft. long; 57 ft. beam; 42.10 ft. depth of hold; gross tonnage about 9,200.

Sch. Fannie Palmer.—The five masted schooner *Fannie Palmer* was launched at the yard of George L. Welt, Waldoboro, Me., on November 8. The vessel is of these dimensions: Length of keel, 257 ft.; beam, 44 ft. 6 in.; depth of hold, 25 ft.; gross tonnage, 3,700 tons.

S.S. City of Everett.—The steamer *City of Everett*, built by the Seattle & Everett Navigation Co., at the Sumner Iron Works of Everett, Wash., was launched recently. The steamer was presented with a handsome set of colors by the citizens of Everett.

A settlement has been reached in the armor plate dispute by which the steel companies are to receive $420 a ton for Krupp armor. The Krupp process involves the Harvey patent, the validity of which is now under consideration by the courts, and it is agreed between the manufacturers and the government that the latter will assume in addition any liability for the Krupp process not exceeding $24.32 a ton for the Krupp royalty, and not exceeding $11.20 a ton for the Harvey royalty. The maximum price to the government is, therefore, $455.52, subject to diminution in case of any reduction in the royalties. The former bids of the companies now in agreement were $490 for this class of armor, and the original price asked was $545.

In his annual report, Chief Constructor Philip Hichborn, U. S. N., makes a plea for the construction of war vessels in the navy yards, so that the yard staffs may be kept as complete and efficient as naval organization requires. He points out that in foreign countries this practice is carried out extensively. The number of war vessels building in government dock yards at the present time is given as: England, sixteen; France, seventeen; Germany, eight; Russia, six; Italy, three.

CHARLES H. HASWELL, M.E.

BY GEORGE W. BAIRD, U. S. N.

The subject of this sketch is probably the oldest engineer now living, having been born in New York City, May 22, 1809. He received a classical education at the Jamaica (L. I.) Academy, and practical mechanical training at the West Point Foundry, N. Y., and Allaire Works, N. Y. He was a skilful draughtsman at an early age, and possessed of exquisite taste in the matter of beauty of design.

He entered the Navy as a chief engineer at the age of twenty-seven; it was before the creation of an Engineer Corps, in the time when engineers were employed in the Navy for limited periods, or for a cruise, and in the day when tacks-and-sheets were supreme. Steam, as a motive power, was not only held as an innovation, but unbecoming to a "man-of-war." As the boilers pretty well filled the main hold, displacing water and provisions, it was not expected that the innovation would be of long duration.

The first steamship was built for the Navy in 1814; she was blown up by her own magazine in 1829, without ever having gone outside of Sandy Hook. The second steam vessel was the *Sea Gull*, 150 tons, purchased in 1822, and sold in 1840. The *Poinsett*, the third steamer, 250 tons, was built in 1840, and transferred to the War Department in 1845. So, when Mr. Haswell entered the Navy, there was but one steamship in it. He had more or less to do with the building of all the steamers for the Navy (twenty-seven in number) up to 1852, when he severed his connection with the Navy and opened an office in New York as consulting engineer.

He was appointed Engineer-in-Chief of the Navy in 1836; at that time the Navy Department was managed by the "Board of Commissioners," and the constructors, engineers and draughtsmen, and clerks, were all subordinate to that Board. At that time it was not the custom to draw details on paper; indeed, general plans were sometimes but sketches, and the details were drawn upon wooden boards in the shops. For a time, Mr. Haswell had but one draughtsman and but one clerk to help him, and found it imperative to lead in both draughting and clerical work; the routine work of the office, the records of the steamers, the requisitions from and supplies for those vessels, were subjects that all passed over his desk. The prejudice against engines, and against the engineer, in that day, was intense; that, however, was but natural, for with the new motive power came the black coal to soil the sacred quarterdeck, and with it came the premonition that the glory of seamanship was waning; the fight between coal whips and tacks-and-sheets had been initiated.

Congress, in its wisdom, sought, at that time, the best engineering talent the country afforded. Commodore Stockton brought Mr. Ericsson to the Navy Department in 1842, and he was employed to design the engine of the *Princeton*. Mr. Copeland, the principal engineer of the Navy, was employed to design the *Michigan, Mississippi, Susquehanna* and *Saranac*; but both of those engineers complained of interference and hardships imposed by the Commissioners. Mr. Haswell, alive to the needs of the service, advised competitive designs, and often plead for money for experiments, urging that the cost of such experiments could only be borne by a Government. The machinery of the *Missouri*, a sister ship of the *Mississippi*, was designed by Mr. Haswell; the two vessels were equally efficient. The machinery of the *Powhatan*, a sister ship of the *Susquehanna*, was designed by Mr. Haswell; the two vessels were equally efficient. Both of these vessels had double inclined engines (according to Mr. Copeland's patents), and the leading dimensions were nearly identical; they differed only in detail. They were the first paddle wheel engines to have wrought iron frames and adjustable cut-offs. Every one of the above named vessels was eminently successful; so well were the details worked out that I doubt if they could to-day be excelled if the same conditions were imposed (pressure, jet condenser, speed of piston, etc.) as then prevailed.

Mr. Haswell was an early advocate of the screw propeller for war vessels. In this, he was opposed by many of the best engineers, and he felt himself between two fires, the sailor element on one side, and the engineers on the other. In 1848, two similar ships were laid down, the *Saranac* to have paddles, and the *San Jacinto* to have a screw propeller. Mr. Copeland designed the engine of the former, and Mr. Haswell of the latter. Mr. Haswell was overruled by the constructor, whose decision was confirmed by the Board of Commissioners, and he was thus obliged to run the propeller shaft through the stern to one side of the stern post; it was held that to cut the stern post would weaken the ship. The whole plan of the engine was essentially new; inventions were necessary to meet new contingencies, and some mistakes were made in the details. So the *Saranac* proved the better of the two, and, for a time, the paddle wheel was held to be the superior. But, ultimately, the *San Jacinto* was so improved that she beat the *Saranac's* best record.

Mr. Haswell was the first man to use zinc to prevent the internal corrosion of boilers. He designed the first steam launch (1837) ever built, and urged the Department to use this type of boat.

In 1842, the Navy Department was reorganized; the Board of Commissioners was succeeded by the Bureaus. The Engineer-in-Chief was placed under the Chief of the Bureau of Construction, and thus the number of persons who might overrule him was greatly diminished. He then, very wisely, began the task of creating an Engineer Corps in the Navy. It had been already found, on board the steamboats in the river trade, that a complete divorce between the "deck" and "engine department" was essential to success, viewed from a stockholder's standpoint. Besides that, trades, arts and crafts were rapidly running to specialties: "to be a good engineer," Mr. Haswell said, "one must be first an engine builder, and, second, an engine designer." He so laid down the prerequisites for their qualifications and examination, and in 1844 he was able to enlist the aid of the whole Navy Department, and then Congress established the Engineer Corps of the Navy. On these lines, the service was able to procure the best talent the country afforded; that corps existed during three wars. The records show that about 20 per cent of the applicants

MODEL FOR BRONZE BUST OF CHARLES H. HASWELL, M.E., TO BE PLACED IN SMITHSONIAN INSTITUTION.

gained admission; about 50 per cent of these were promoted to second assistant; and only about 50 per cent of the remainder reached the grade of chief engineer. Mr. Haswell rightly devised a method of promotion by selection, without the usual objections. "With such a system," he said, "we will get a superior class of chief engineers, who belong in the category of self-made men."

In 1855-7, Mr. Haswell was a member of the civic Board of Councilmen of the City of New York, and was its president in 1858.

In 1862-3, he was in command of an army transport steamer in the Burnside expedition, and, in the attack on Roanoke Island, he ran his vessel under fire (Fort Baxter) to the assistance of the gunboat *Ranger*, and pulled her off the shoal on which she had grounded.

For many years he was surveyor of steamers for the underwriters at New York, Boston and Philadelphia. He designed and located the buildings on Hoffman Island (New York Harbor), the crib bulkhead at Hart's Island, and the foundations of some large buildings in New York City. He is now consulting engineer for the New York Board of Public Works, and is also superintending the extensive constructions and improvements at Riker's Island.

He is the author of the famous mechanic's pocket book, now in its sixty-fourth edition—that book, which made the elements of engineering so easy to many of us, and which so delighted the Emperor of Russia that he sent Mr. Haswell a diamond ring. There was not then, nor is there now, a decoration for an engineer. For the soldier who destroys life, or the physician who saves it, there is a decoration in Russia, which may be given to foreigners. In the great art emporiums of Europe there are countless memorials of men who were famous in all other arts and sciences than that of mechanical engineering. It is true that the profession is young, but it has done the work of giants in its youth.

A few months ago I sent a circular letter to Mr. Haswell's friends, those in the Navy and out of it, which has brought sufficient contributions to enable me to have made a very fine bronze bust of Mr. Haswell, as he appears at the age of ninety-one. This will be placed in the Smithsonian Institution at Washington, with those of Fulton, Ericsson and Stevens.

Mr. Haswell has always been held in high esteem by engineers. Once, when Mr. Ericsson declined to be a Commissioner to the Paris Exposition, he was asked to recommend a man; he named Mr. Haswell, and said: "Very few professional men combine such perfect practical and theoretical knowledge as Mr. Haswell."

Mr. Isherwood, that master of engineering, once said: "At that period" (referring to Mr. Haswell's incumbency of Engineer-in-Chief of the Navy) "marine engineering was in its infancy; it had no science and but little art. Mr. Haswell added the former, and greatly improved the latter. His designs are still admirable, and the beauty and propriety of their details, most of them entirely original, testify to his professional skill."

SUBMARINE BOATS — FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.—III.*

BY CARL BUSLEY.

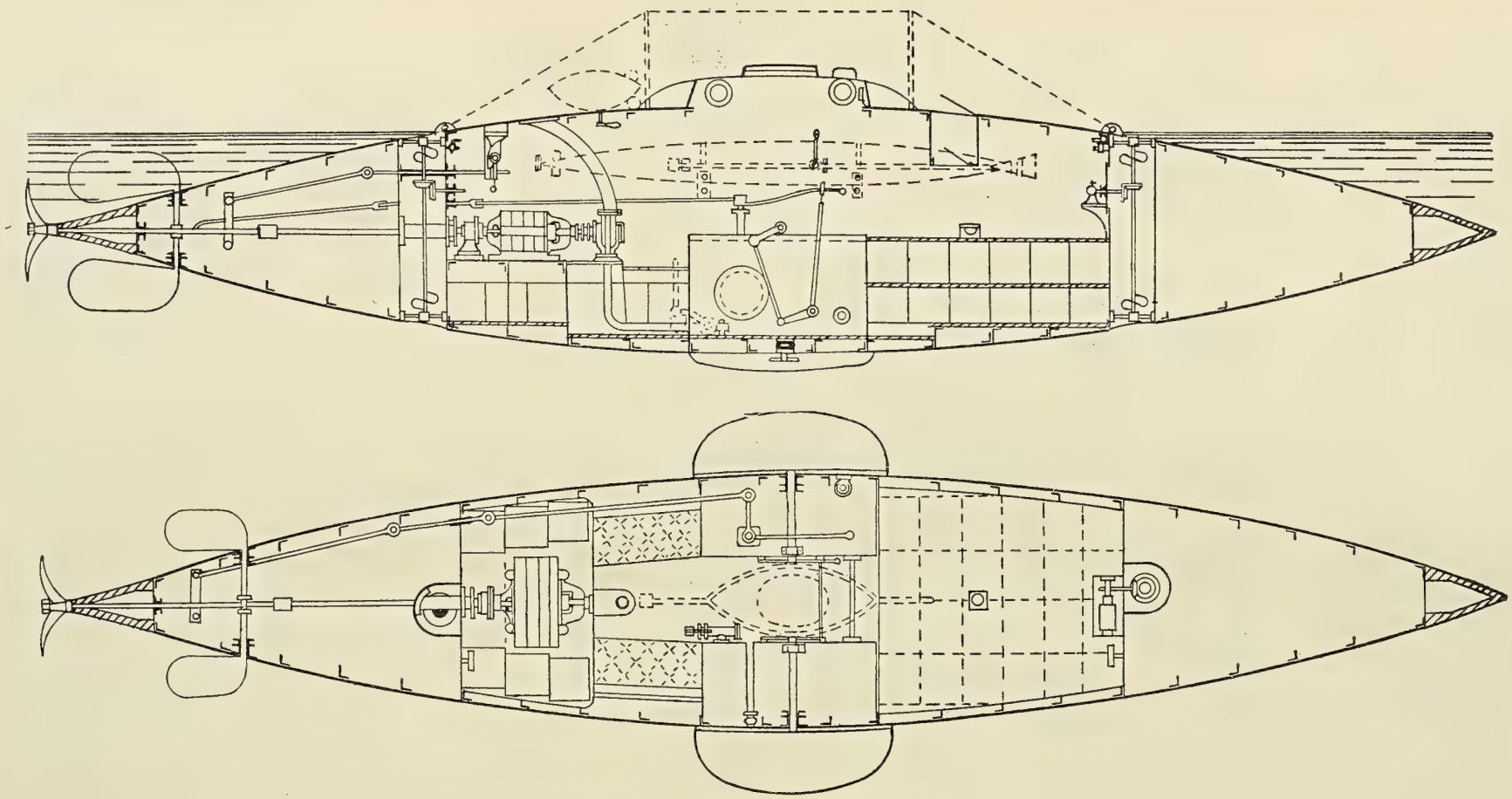
CHAPTER XIII.

Waddington's Porpoise, 1886.—In 1886 there was placed on exhibition at the exposition at Liverpool, a submarine boat as shown in Figs. 25 and 26, designed by an Englishman named Waddington. It was 35 ft. long and 5 3-4 ft. dia. amidships, and was fitted with four vertical propellers, two on a shaft, one set near the bow, and one near the stern, and also two horizontal rudders amidships, with the necessary hand levers to operate them, as shown in Fig. 26. The same drawing shows also the horizontal rudders attached to the after end of the boat, which were held in position by pendulums, with the intention of correcting any heavy pitch by the rudders amidships. The conning tower was equipped with a vertical rudder similar to the after horizontal rudder. The motor current for driving the propeller was furnished by 45 storage batteries. These were sufficient to develop 8 horse power for ten hours, and gave the boat a speed of 8 knots when she floated on the surface. The motors also drove the centrifugal ballast pump. Each of the two pairs of vertical propellers also had its separate electric motor. Each end of the boat was fitted with a receptacle for compressed air, which was to be used solely for renewing the air in case this became necessary. Under ordinary conditions, however, the two men of the crew could remain inside for a time of six hours without requiring a renewal of air. The weapons of the *Porpoise* were two Whitehead torpedoes, which were carried alongside, as shown by the dotted lines (Fig. 25), and which could be released by means of levers. The trials of the *Porpoise* when sailing on the surface were satisfactory, but nothing is known of her trials under water, so that the conclusion generally accepted is that such trials were never attempted, or if attempted were so unsatisfactory that the details were not made public.

CHAPTER XIV.

Campbell's Nautilus, 1886.—On the 27th of November, 1886, the submarine boat shown in Figs. 27 to 29 was tried in the West India Docks, in London. This boat, designed by Andrew Campbell, and built by Wolesly & Lyon, had a length of 57 ft. and a maximum dia. of 7 1-2 ft. and a displacement of 52 tons when fully submerged. The twin propellers were driven by two motors of 45 horse power, which were designed by Graydon Poor and built by Lewis Olrick & Co. The electric current was stored in 180 Elwell-Parker storage batteries, and these were systematically arranged on both sides amidships. The vessel was built of plate with angle iron frames. The interesting part of this boat lies in the system of increasing or decreasing her displacement as a means of diving or coming to the surface. Four horizontal cylinders of 20 in. dia. were fitted on either side, and these could be pushed out about 20 in. so as to increase the displacement by about one half a ton. This telescopic action was connected to the power plant, and the speed by which the displacement could be altered was sup-

*Translated from the proceedings of the German Society of Naval Architects and Marine Engineers, Berlin, Germany



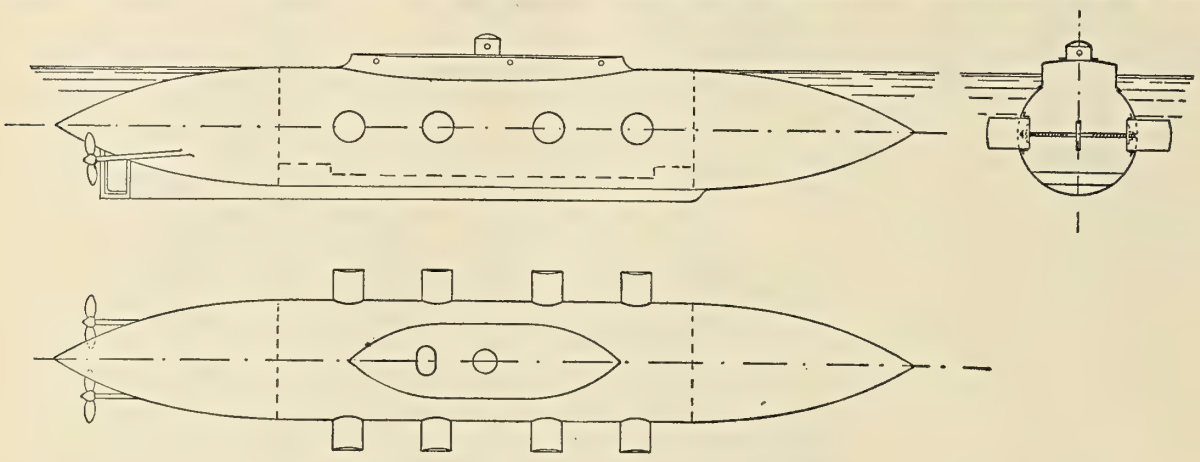
FIGS. 25 AND 26.—WADDINGTON'S PORPOISE, 1886.

posed to give quick results as far as the diving and raising action was concerned. Unfortunately, there are no reports of the performances of this boat further than that she went down 15 ft. to the bottom of the dock in a horizontal position, and also made several short trips below. Naturally, the projecting cylinders were a serious detriment to speed, and it can hardly be believed that the boat made a speed of eight miles an hour when submerged, as had been promised by the makers of the 45-horse power motors. After the few first trials nothing further was ever heard of the boat.

CHAPTER XV.

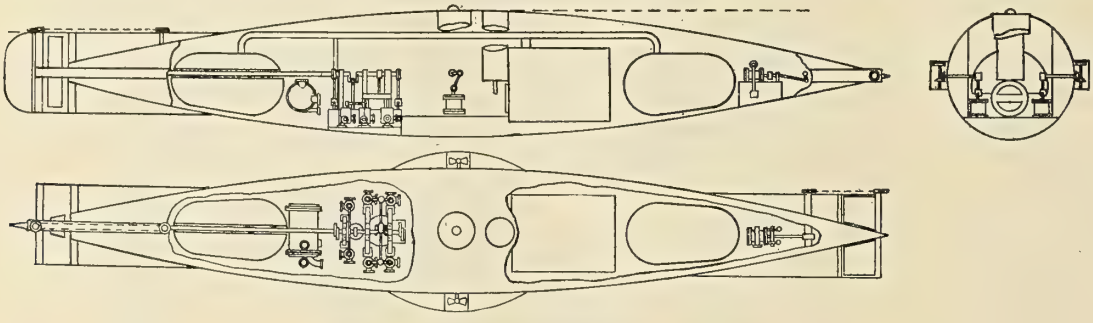
Nordenfelt's Boat, 1885.—In September, 1885, in Landskrona, the Swedish engineer, Nordenfelt, tried his submarine boat in the presence of a number of representatives of different navies. He built this vessel in 1883-1884, at Hartlwick, by Stockholm. It was built of mild steel, 64 ft. long, 9 ft. beam, 12 ft. depth, and when totally submerged it had a displacement of 60 tons (Figs. 30 and 32). The manhole at the top

center was fitted with a small glass observation tower about a foot high, from which the operator could make his observations. At the after end the boat was fitted with a four-bladed screw propeller, and a vertical rudder, and at the forward end there were two horizontal rudders, one on each side, and connected by balance weights. The duty of the latter was to bring the boat back to the horizontal position whenever it should happen to incline. The interior of the boat was divided into five compartments, of which the forward and after compartments contained a tank for water under high pressure and temperature. The crew occupied the central compartment, and the two others contained the engine and boiler. The engine was a compound of 100 I. H. P., and fitted with a surface condenser. Steam was generated in an ordinary Scotch boiler with a coal fire when the boat sailed on the surface, and was taken from the two pressure tanks when sailing below. The details of this system will be more fully explained in the following chapter on the Turkish boats. Nordenfelt declared that his boat could attain a speed of 14 knots under water when using the steam from the storage tanks.



FIGS. 27, 28 AND 29.—CAMPBELL'S NAUTILUS, 1886.

When the boat floated on the surface, a small ventilating fan driven by a small engine was used to force air into the compartments and reduce the high temperature caused by the steam machinery. When submerged, the same effect was expected to be produced by a circulation of cold water, although the temperature did rise as high as 90 deg. The enclosed air was sufficient to last six hours for the crew of three men. In order to submerge the boat the double bottom was flooded to such an extent that only a small flotative capacity was left in the craft, and this was counteracted by the vertical diving propellers similar to Bushnell's. These propellers were fitted either side of the boat at the middle—(Fig. 32)—and were operated by a small 6 H. P. engine. The steam pipe to this small engine was fitted with a throttle valve which was connected by means of links to a piston. This piston had the pressure of the outside water on one side and the pressure of a graduated lever with a weight, on the other side. By means of this arrangement it was intended to regulate the depth of the submersion of the boat by shifting the position of the weight on the lever, thus regulating the speed of the diving propellers.



FIGS. 30, 31 AND 32.—NORDENFELT'S BOAT, 1885.

TURBINE DRIVEN VESSELS.—In response to criticism regarding the coal consumption in turbine driven vessels, Charles A. Parsons has made a statement of facts and figures, which is distinctly favorable to the turbine system. In the case of H. M. S. *Viper*, of over 36 knots maximum speed, the coal consumption at 31 knots, official trial, was 2.38 lb. per I. H. P. per hour. On another trial, with the air pressure limited to 3 1-2 in., a mean speed of 33.83 knots was maintained with about one-fifth of the maximum power, with coal consumption at the rate of 2.49 lb. per I. H. P. per hour. In this vessel speed rather than fuel economy was the result sought, the inventor states, but in future vessels he hopes to be able to beat all previous records as to economy in coal. The economy of the *Viper* was equal to that of the ordinary 30-knot destroyer.

TECHNICAL PUBLICATIONS.

INJECTORS: THEIR THEORY, CONSTRUCTION AND WORKING. By W. W. F. Pullen. Second Edition. The Technical Publishing Co., Ltd., Manchester. Size, 5 by 7 1-4. Pages 187. With many illustrations. Price, $1.50.

The working of an injector, especially one of modern type, is a subject on which comparatively few engineers can give exact information, and is entirely a matter of mystery to the uninitiated. In this very concise and carefully written book the Author has given lucid explanations of all questions, both as to action and design. The first chapter opens with a popular explanation of the action of the steam injector. Then follows a mathematical investigation of the velocity of efflux of the steam jet. For those who are not able to follow the mathematical deductions, a series of tables have been constructed giving the principal data and results which may be needed in calculations of sizes and capacities. In the large number of illustrations the Author has endeavored to give examples of the different forms rather than examples of each manufacturer's apparatus. Of the examples given comparatively few are of American origin. This, the Author states, is due to the difficulty of obtaining such, together with the impossibility of consulting any American patent records. The first nine chapters deal with the elementary principles, calculations and sizes of cones, working limits, weights of water delivered. Then follow the descriptions of the simple nonlifting injector, its adaption to different kinds of locomotive work, with the gradual improvements. Then follow the lifting, automatic and retarding injectors and modifications of the same. The chapter on exhaust and compound injectors is very complete. Different styles of ejector condensers are shown, also their calculations and efficiency, and a short article on steam injectors for air blast. The chapter on air ejectors for producing vacuum for railway brakes is well illustrated, and several styles of injector for oil burning in marine boiler furnaces are also mentioned.

ENGINE TESTS. By George H. Barrus, S.B. First Edition. D. Van Nostrand Co., New York. Size 6 by 9 1-2. Pages 339. With numerous illustrations. Price, $4.00.

All who are interested in the economical development of power by means of steam boilers and engines will doubtless remember Mr. Barrus's "Boiler Tests" published in 1891. The favorable reception accorded this collection of boiler test results has lead the Author to prepare and publish a series of similar results drawn from his tests of steam engines. The book, as a whole, is divided into two parts. In the first of these the general subject of engine testing is considered in an instructive manner, and a description is given of the methods used by the Author, together with references to the use of indicators, the working up of results, the calibration of instruments, etc. In the second part is found the collection of results classified according to the type of engine under consideration. This is followed by a general review of the results given by the tests, including a discussion of the following topics: Cylinder condensation and leakage; effect of pressure on economy; economy of condensing; effect of superheating; relative economy of simple, compound and triple expansion engines; economy of steam jacketing and reheating in compound engines; effect of ratio of cylinder areas in compound engines, etc. This is followed by a section on valve setting by the aid of the indicator, and by a collection of steam-pipe diagrams showing the fluctuations of steam pressure in the pipe during the revolution of the engine.

Returning to the actual tests, the results in each case are collected and shown in tabular form followed by a brief explanation of any special circumstances which may have been present. Sample indicator cards are also shown, thus adding greatly to the value and interest of the results obtained. The experimental part of the work seems to have been well planned and carried out, so far as may be judged from the description of methods used, and the tests cover all the leading types of engines employed in stationary practice. The results will therefore be of the widest interest to all who are concerned with this field of engineering and especially to those who may have to deal with the design and installation of stationary central station or power plants. The book is well printed, and the indicator diagrams with which its pages abound are of good size, well selected, and well executed as examples of the engraver's and printer's art.

A new technical publication, *The Power Quarterly*, has just been issued to fill a demand for recent copies of *Power* containing matter on this subject. The *Quarterly* contains a complete synopsis of gas engines in foreign countries, as shown at the Paris Exposition, including a description of a gas engine operated by blast furnace gas (18 pages, 49 illustrations), a technical description of the leading American gas engines (23 pages, 77 illustrations), a reprint of the serial in *Power* on the principles of the construction and operation of gas engines (20 pages, 30 illustrations), an illustrated description of a producer plant for the manufacture of gas for gas engine purposes, editorials on the efficiency of the gas engine and its commercial advantages, and other matter relative to industry. Copies can be had for twenty-five cents each by addressing the Power Publishing Co., 145-148 World Building, New York.

The "Practical Engineer Pocket Book" for 1901 has been issued by its British publishers, and is now on sale in this country. This is one of the lowest priced pocket books in the market, and it contains a large amount of useful information for reference. Some of the chapters cover: weights and measures, steam boilers and furnaces, steam and the steam engine, oil engines, turbines and windmills, transmission of power by shafts, belts, ropes and gearing, screws and screw threads, crane boots, friction, inertia and strength of materials. There is also a special section on mining machinery. The book is really pocket size and, in leather covers, is sold for 1s. 6d.

Work on the new defender of the America's cup has been commenced in the Herreshoff shops, Bristol, R. I. On the other side of the Atlantic, the order for the competing yacht has been placed on the Clyde by Sir Thomas Lipton, the contestant.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Will you kindly inform me the best internal proportions for a 66-in. by 96-in. Scotch water back marine boiler to burn common wood fuel, and to be allowed 155 lb. steam pressure? I do not refer to thickness or dimensions of material, but in particular to the length of flues, the length of combustion chamber and the width of the water space in the back head. It is proposed to use seventy-six 3-in. tubes and a furnace 30 in. dia. R. M. P.

A.—The dimensions given—boiler 66 in. dia., length 96 in. and furnace 30 in. dia.—are about as good as can be made, although the diameter of the tubes might be reduced to 2 1-2 in. or even 2 1-4 in. and the diameter of the furnace increased as much as possible, with good results. The water space at the back and around the back connection should be 4 in., the back connection about 16 in. in the clear; and the furnace and tubes about 76 in. long. Grate bars for burning wood in such a boiler are not wanted; but only two or three cross bars about 4 or 5 in. from the bottom to admit the air necessary for combustion. The success of such a boiler depends greatly upon proper firing; the wood should be fed often and in small quantities, keeping the fresh fuel well in front and pushing aft as the combustion progresses.

Q.—Will you please answer the following in your query and answer column: If I were sent to some small town to fit out a steamboat and found that the crank pin brasses and crosshead brasses had been stolen, and that there was no machine shop in the neighborhood, how should I proceed to take templets and measurements in order to have a new set made at some distant shop? E. C. P.

A.—If all the other parts of the engine are intact, there will be but little trouble to make sketches and gauges for the boxes.

In the first place, ascertain the stroke of the engine. When the piston rod, crosshead, slippers and guides are in position and cylinder cover on, push the piston to the top of the cylinder as far as it will go, and do the same on the bottom, and mark these two positions on the guides. The distance between these two positions will be equal to the stroke plus the top and bottom clearances. If the measured distance were 37 in. and the stroke 36 in., this would leave 1 in. for clearance or 1-2 in. top and bottom. Then place the crosshead 1-2 in. below the top mark and you will have the right position for the crosshead when the crank is at the top. Then measure the distance between centers of crank pin when in the top position and crosshead pin, and also the distance between the faces of the pins.

If the connecting rod has gib and cotter ends, measure the distance between the butt ends. Deduct the distance between the faces of the pins, and you have the combined thickness of the two brasses between the pins and the butt ends of the rods. You must then use your discretion as to how this must be divided. Suppose the crosshead pin were 4 in. dia., the crank pin 7 in. dia., and you found the distance between centers of connecting rod to be 7 ft. Then the distance between faces of pins would be 6 ft. 6 1-2 in. Then suppose you found the distance between butt ends of connecting rod to be 6 ft. 4 in. Deduct this from 6 ft. 6 1-2 in., which would leave you 2 1-2 in. as the combined thickness of both boxes between the butt ends and the pins. This could be divided as follows: Leave, say, 2 1-2 in. thickness at crank pin and 1 in. thickness at crosshead pin. Then put the straps, gibs and cotters in correct position on the connecting rod, and then you will have the correct relative position of pins in each, and you can sketch boxes to fit the gaps in each. Measure the distance between the crank faces and deduct the usual amount of clearance, and you have the width of the box. Deduct the width of the butt end of rod, and one-half of the remainder gives the width of each flange, or the flange and its circular projection. The amount that the flange overlaps the strap you can judge by experience. It is usually 1 1-2 times the width of the flange. Proceed in the same manner to get widths for the crosshead box. Make a gauge of the diameter of the crosshead pin, and also one of the crank pin. Furthermore, gauges for the widths of the butt ends and between edges of straps are necessary, so that the boxes will fit snugly into the straps.

The method of procedure will be the same for any other style of connecting rod, such as strap, gib and cotter at crank pin end, and the crosshead end forked with two boxes, or if the boxes are of the English type, each with two bolts. It is merely a matter of determining the relative position of the crank pin and crosshead pin to the two ends of the connecting rod, and building boxes to fit the ends and spaces between which they work.

If you wished to have the boxes made before the engine was erected, you would have to know the distance between centers of pins, or what is commonly called the length between the centers of the connecting rod. If you could not get this information, you would have to wait until the cylinders were up and then proceed as described. If a man has had experience in erecting a certain class of engine, it would be possible to get the measurement approximately by calculation and measurement of the parts before assembling, and have the boxes cast and machined to fit the ends and pins, leaving material to spare between the pin and butt end, so that it would be a small job to finish them when the final measurement arrived; or if they were small boxes, the finishing could be done on board by hand.

ENGINEERS' DICTIONARY.—XXXI.

Outboard Delivery Pipe.—The pipe which leads the water from the condenser to the side of the ship, whence it is discharged overboard.

Outboard Delivery Valve.—The valve through which the water is discharged at the outboard end of the delivery pipe. See illustration under EDUCTION VALVE.

Overhung Crank.—A crank in which there is but one web or crank throw A B, and in which the load carried by the pin A C is supported by one bearing only at or near D. (Fig. 90.)

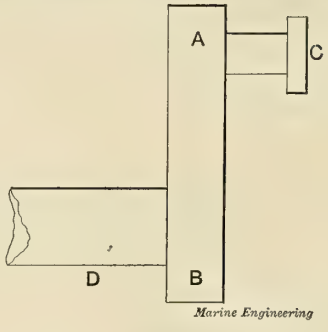


FIG. 90.

Overhung Paddlewheel.—The shaft of a paddle steamer is usually provided with an outer bearing on the guards, and an inner bearing on or near the main rail, thus supporting the weight of the wheel between the two bearings. In some cases the outside bearings have been omitted, and in such case the paddle wheels are said to be "overhung."

LOSS OF PASSENGER STEAMER.—A small side wheel steamer, the *City of Monticello*, foundered in the Bay of Fundy, in a gale, on November 10, and more than thirty persons are reported to have been drowned. The vessel plied between St. Johns, Yarmouth and Halifax, N. S., and belonged to the Yarmouth Steamship Co. She was a side wheel iron boat of about 1,000 tons register, built at Wilmington, Del., in 1866. Only one boat got away from the ship safely, and this was dashed to pieces on the shore, only four of the occupants being saved.